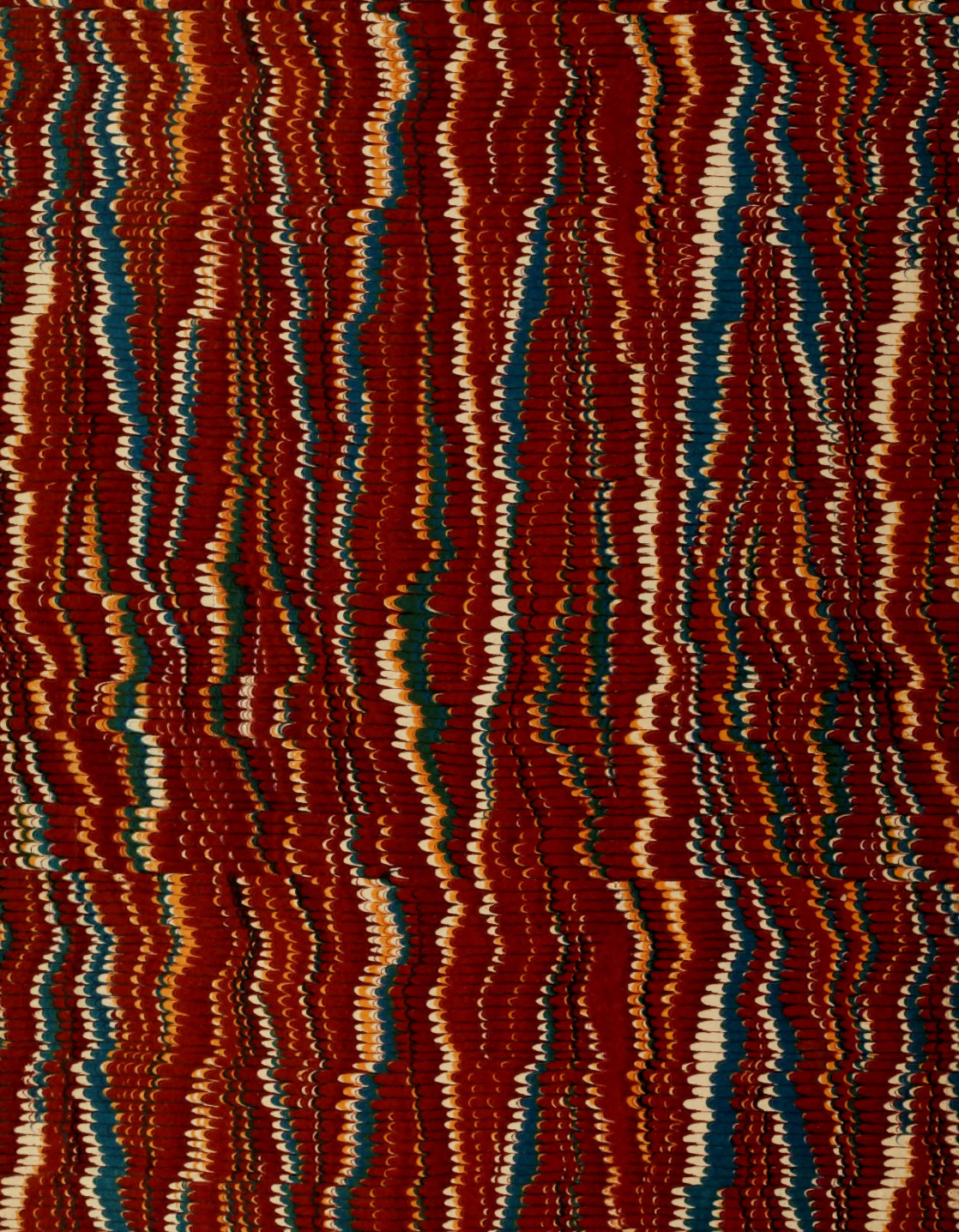

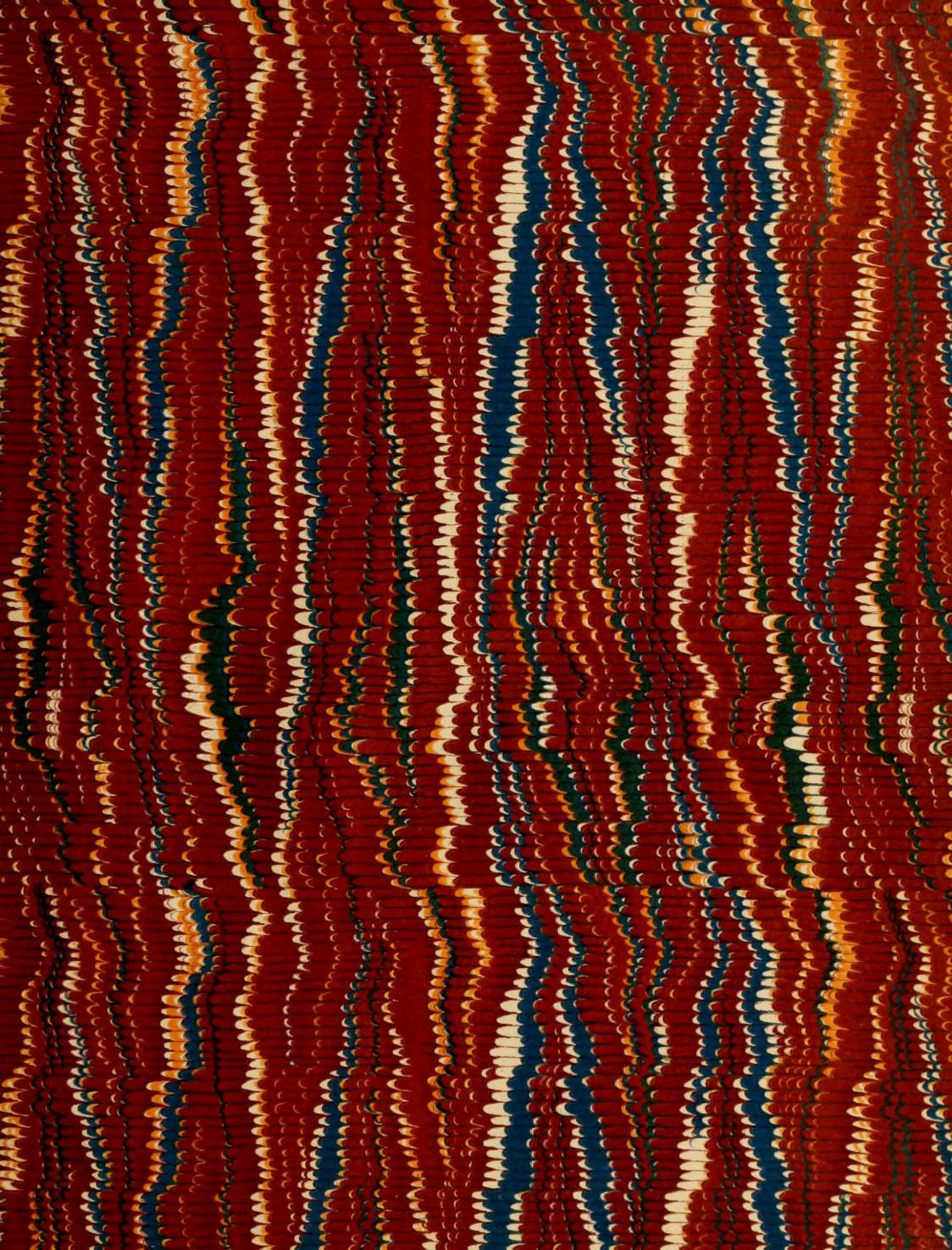

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MONOGRAPH OF THE CARBONIFEROUS CEPHALOPODA OF IRELAND.

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MONOGRAPH

OF THE

CARBONIFEROUS CEPHALOPODA

OF

IRELAND.

BY

ARTHUR H. FOORD, Ph.D. (Münch.), F.G.S.

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ON THE

CARBONIFEROUS CEPHALOPODA

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ARTHUR H. FOORD, Ph.D. (Münch.), F.G.S.

PART I.

Family ORTHOCERATIDÆ (in Part).

Pages 1—22; Plates I—VII.

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MONOGRAPH

ON THE

CARBONIFEROUS CEPHALOPODA OF IRELAND.

Sub-order NAUTILOIDEA.

Family Orthoceratidæ.

A. Longicones.

I. *Group* Lævia.

Sub-group *Cylindriformes* (*siphuncle cylindrical*).

Genus Orthoceras, *Breyn*, 1732.

Orthoceras Leinsterense, *A. H. Foord.* Plate I, figs. 1 *a*—*c*.

1896. Orthoceras Leinsterense, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 13.

Description.—Shell somewhat elongate, straight, tapering at the rate of about 1 : 7. Section elliptic, perhaps partly by pressure, the ratio of the greater to the lesser diameter being as 7 : 6. Body-chamber of moderate length, about 120 mm., which probably represents not more than one-fourth of the entire length of the shell; the specimen, however, is not perfect enough towards the apex to supply material for accurate measurement. There is a small, well-marked constriction on the cast of the body-chamber, just below the aperture, but this

can only be seen when the test has been removed. The edge of the aperture is preserved in one place. Septa somewhat oblique, crowded together in the younger part of the shell, making the chambers here very shallow, their depth being less than one-fifth of their diameter. Nearer the body-chamber, however, the septa rapidly widen their distance, so that within a space of 75 mm. their distance apart is nearly doubled. Siphuncle, as determined by the necks of the septa, lies at a distance of about three-eighths across the diameter of the shell, probably cylindrical; the tube itself has, however, been destroyed by crystallisation within the chambers, which are filled with crystalline calcite. Test rather thick, especially that of the body-chamber; its surface marked with obscure lines of growth, which are more conspicuous upon the body-chamber than upon the rest of the shell. The shell may, nevertheless, be regarded as essentially smooth.

Size.—Length of the largest specimen 347 mm., but a considerable part of the apical end is broken off. Greatest diameter 62 mm., least 30 mm.

Affinities.—A comparison between this species and *Orthoceras variabile* is made under the description of the latter, but I am not acquainted with any other species with which it may be compared.

Remarks.—The most noteworthy feature in this species is the rapid transition from the closeness of the septa in the apical and central parts of the shell to their wide separation towards the body-chamber.

Locality.—Clane, county of Kildare.

ORTHOCERAS VARIABILE, *A. H. Foord.* Plate I, figs. 2 *a*—*d*.

1896. ORTHOCERAS VARIABILE, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 19.

Description.—Shell moderately elongate, tapering at the rate of 1 : 6. Section elliptic, the ratio of the two diameters as 11 : 9. Body-chamber slightly inflated, the apertural end not preserved; therefore its length relative to that of the entire shell cannot be computed. Septa extremely numerous in the apical and central portions of the shell, gradually increasing in width apart until the body-chamber is reached; thus in a section of the shell measuring 15 mm. in diameter the septa are only 3 mm. apart, and where the diameter has increased to 30 mm. they

are 5 mm. distant, while the last two septa are separated by an interval of 10 mm. The septa, as seen in a longitudinal section, are somewhat displaced by mineralisation, but they preserve on the whole their normal form. Siphuncle excentric by about its own diameter; cylindrical, rather wide. Test smooth.

Size.—Length of the largest specimen about 360 mm. Diameter of the base of the body-chamber 55 mm., that of the apex 12 mm.

Affinities.—This species is evidently related to *Orthoceras Leinsterense*, from which, however, it differs in its higher rate of tapering and closer septa. In its very numerous septa it is comparable also with *Orthoceras princeps*, de Koninck, but the latter has a much more rapidly tapering shell, and more evenly spaced septa.

Remarks.—This beautiful species appears to be rare; I have met with only two or three examples of it. The most marked feature in it consists of the very numerous septa, which greatly exceed in number those of most species of Orthoceras of this size. Their original structure has been considerably modified by crystallisation; the necks of the septa are often pushed out of place, as in the example figured, which only shows a small portion of the siphuncle proceeding downwards from the penultimate septum.

Locality.—Clane, county of Kildare.

ORTHOCERAS COLEI, *A. H. Foord*. Plate II, figs. 1 *a*—*c*.

1896. ORTHOCERAS COLEI, *A. H. Foord*. Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 18.

Description.—Shell elongate, tapering at the rate of about 1 : 6. Section normally circular, but elliptic by pressure, as is proved by the distortion of the septa at the sides (Pl. II, fig. 1 *b*). Body-chamber about 155 mm. in length in a specimen measuring about 600 mm., or about one-fourth of the whole length of the shell.[1] There is a well-marked constriction on the cast below the aperture, which constriction is as usual covered by a thickening of the test when the latter is present. Septa very deeply concave, distant from each other about one-third of the longer uncompressed diameter of the shell. Siphuncle cylindrical, wide, being from one-eighth to one-ninth of the diameter of the shell near the body-

[1] The specimen is preserved nearly to the apical point, but there is an intermediate piece lost which must have measured about 80 mm.; this has been added in computing the total length.

chamber ; excentric, situated at a point which is about two-fifths of the distance across the longer diameter of the shell. Test smooth.

Size.—Length of the largest specimen met with about 600 mm. ; greatest diameter 67 mm., least 6 mm.

Affinities.—*Orthoceras Leinsterense* most nearly resembles this species, but the two are very easily distinguished. In *O. Leinsterense* the septa are remarkably approximate in the earlier and middle portions of the shell ; in *O. Colei*, on the other hand, the septa are more regularly spaced, their distance apart increasing gradually with the growth of the shell. The rate of tapering in the present species is also higher than in *O. Leinsterense*. I find none of de Koninck's species comparable with the present one.

Remarks.—Only two or three specimens of this species have been obtained up to the present time, but they present constant characters, which may be easily recognised when suitable means are taken to develop them. These consist in the preparation of sections, longitudinal and transverse, the former being of special importance, as it is necessary to ascertain the structure of the siphuncle and its relation to the septa, as well as the characters of the latter. My experience has taught me that very few species of these straight-shelled cephalopods can be determined by the external characters alone, except in cases where there is a well-marked ornamentation. The species is named after Professor G. A. J. Cole, F.G.S., of Dublin.

Locality.—Clane, county of Kildare.

ORTHOCERAS NOLANI, *A. H. Foord*. Plate III, figs. 1 *a—f*.

1896. ORTHOCERAS NOLANI, *A. H. Foord*. Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 20.

Description.—Shell straight, elongate, tapering at the rate of 1 : 7. Body-chamber about one-fourth of the length of the entire shell, with a well-marked constriction posterior to the aperture. Section elliptic, partly if not wholly by compression, the ratio of the two diameters being as 4 : 3. The septa are moderately distant, being 10 mm. apart where the shell diameter reaches 32 mm., this distance increasing to 15 mm. where the diameter is 42 mm. The chambers are deep, but not so deep as they appear to be, owing to the compression of the shell, which has pushed the septa inwards, bringing part of them nearly parallel

in some places with the siphuncle. The septa are otherwise well preserved. Their short "necks" are easily seen in longitudinal sections, a slight expansion of the siphuncle marking their termination (Pl. III, fig. 1 *d*). The siphuncle is slightly excentric and of moderate breadth, being about 4 mm. in diameter, or about one-eighth of the diameter of the shell. This proportion, however, would be reduced were the shell uncompressed. The surface of the test is quite smooth.

Size.—The largest example is 520 mm. in length, with an apertural diameter of 70 mm., the apical diameter (almost the extreme apex) being only 5 mm.

Affinities.—This species bears some resemblance to *Orthoceras fandum*, de Kon., but the septa are wider apart, and the rate of tapering is slower. The specimen figured by de Koninck,[1] which I examined when in Brussels in 1893, consists of parts of two individuals, the body-chamber not belonging to the same one as the septate part. From *Orthoceras Colei* the present species is distinguished by its slower rate of tapering and more nearly central siphuncle.

Remarks.—This species is represented by two fine specimens, one of which is nearly complete, wanting only a small part of the apical end. The septa and siphuncle are well preserved in both individuals, though the spaces between the septa are filled with crystalline calcite. Some of the septa are pushed out of shape by rock pressure against the walls of the shell.

I have named this species after Mr. J. Nolan, of the Geological Survey of Ireland, to whom I am much indebted for the kind help he has rendered me in giving me access to works relating to the literature of the subject of this Monograph.

Locality.—Clane, county of Kildare.

ORTHOCERAS SANCTI-DOULAGHI, *A. H. Foord.* Plate I, figs. 3 *a*—*e*.

1896. ORTHOCERAS SANCTI-DOULAGHI, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 17.

Description.—Shell elongate, tapering at the rate of 1 : 9. Section circular when uncompressed. Body-chamber of moderate length, but its proportion to the whole length of the shell cannot be ascertained in any of the specimens collected, as there is none perfect enough to supply the necessary data. The

[1] 'Calc. Carb. Belg.,' 1880, pt. ii, p. 65, pl. xlii, fig. 1.

aperture has an undulating outline, and there is a constriction in the cast of the body-chamber just below the aperture (Pl. I, fig. 3 *d*). Septa exceedingly numerous, undulating, varying very little in their distance apart, this regularity being a marked feature in the species. Siphuncle small, cylindrical, central. Test quite smooth.

Size.—The largest specimen, a cast, entirely septate, and imperfect at both extremities, has a length of 240 mm., the greatest diameter being 38 mm., the least 13 mm.; thus the apical end wants but little to make it complete. It may be added that about 25 mm. of the larger end of the specimen are omitted in the figure to save space.

Affinities.—In general shape, multitude of septa, and position of siphuncle the present species resembles *Orthoceras inopinatum*, de Kon.,[1] but the latter tapers more rapidly, and has still more numerous septa. *O. Nerviense*, de Kon.,[2] has also closer septa than *O. Sancti-Doulaghi*.

Remarks.—The salient character in this species is the great regularity and equality of the septation. The slight ellipticity of the adult portion of the shell is a feature of common occurrence in straight-shelled Orthoceratites, the apical part being usually either circular or much less elliptic than the older part. The specimen figured has its surface roughened by chemical erosion, but the sutures though obscured have not been obliterated, nor are the septa as seen in a section injured. The siphuncle has, however, been destroyed by the formation of small crystals of calcite, which entirely fill the chambers.

Locality.—St. Doulagh's,[3] county of Dublin.

ORTHOCERAS ACRE, *A. H. Foord.* Plate II, figs. 2 *a*—*d*.

1896. ORTHOCERAS ACRE, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 12.

[1] Faune Calc. Carb. Belgique ('Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont.,' vol. v), pt. 2, p. 63, pl. xl, fig. 1; pl. xlii, fig. 2.

[2] Loc. cit., p. 57, pl. xl, figs. 2, 3.

[3] A village about six miles from Dublin, where extensive quarries in the Carboniferous Limestone have long been worked. The parish church of St. Doulagh's, giving its name to the village, is of considerable antiquity, dating probably from the latter end of the thirteenth century; it is reputed to be the smallest church in Ireland. There is a description and picture of it in W. F. Wakeman's 'Archæologia Hibernica.'

Description.—Shell long, very slender, tapering at the rate of 1 : 10. Section nearly circular. Body-chamber too imperfect for description. Septa very oblique, approximate, from 4 to 5 mm. apart, where the diameter of the shell is about 20 mm. Siphuncle excentric, seen only at the apical extremity. The test is quite smooth.

Size.—The most complete specimen measures 280 mm. in length, the greatest diameter being 33 mm., the least 5 mm.

Affinities.—This species bears some resemblance to *Orthoceras Nerviense*, de Kon., especially in the slenderness of its form, but the differences separating it from that species are constant and well defined. These consist in the obliquity of its septa and the excentric position of its siphuncle.

Remarks.—The septal chambers, as is usually the case with the Cork specimens, are filled with crystalline calcite, which has destroyed or distorted the septa and siphuncle. The apical extremity of one of the specimens (Pl. II, fig. 2 *b*) is obliquely truncated, and shows the position of the siphuncle in the shape of a small depression or cicatrix, which was originally covered by the shell, the latter having been here broken off in removing the specimen from the rock (Pl. II, fig. 2 *c*). The initial point of these shells is so rarely preserved that I have given a figure of it from a drawing I made under a camera lucida. The extremely slender habit and other characteristic features have led to the ready identification of several examples of this graceful species among the specimens of *Orthoceras* obtained from the great quarries of Little Island, near Cork.

Locality.—Little Island,[1] near Cork.

ORTHOCERAS CYLINDRACEUM, *J. Fleming.*

1815.	ORTHOCERA CYLINDRACEA,	*J. Fleming.*	Annals of Philosophy, vol. v, p. 202, pl. xxxi, fig. 3. (Not of Sowerby.)
?1844.	ORTHOCERAS CYLINDRACEUM,	*F. M'Coy.*	Synopsis Carb. Foss. Ireland, p. 7.
1855.	—	—	—	British Pal. Foss., fasc. 3, p. 569.
1888.	—	—	*A. H. Foord.*	Cat. Foss. Cephal., British Museum (Natural History), pt. 1, . . . p. 102.

[1] This is no longer an island, the stream to the north that made it one having been filled up; it is therefore a peninsula, and is situated in the fine waterway leading from the city of Cork to Cork harbour.

1896. Orthoceras cylindraceum, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 15.

This species, identified by M'Coy (loc. cit.), has come under my notice, there being examples of it in the Museum of Science and Art, Dublin ("Griffith Collection"), and others in the general collection. It is a small species, remarkable for the closeness and regularity of its septa. The siphuncle is cylindrical and central, the test smooth.

Locality.—Clane, county of Kildare. It is recorded from several places in Ireland in Griffith's localities of Carboniferous fossils (M'Coy's 'Synopsis,' 1862), but I have not seen any specimens except from Kildare.

Orthoceras Nerviense, *L. G. de Koninck.*

1880. Orthoceras Nerviense, *L. G. de Koninck.* Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., vol. v), pt. 2, p. 57, pl. xl, figs. 2, 3.

1896. — — *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 15.

Up to the present time only one specimen of this species has been identified. The characters can be satisfactorily made out, and I have no doubt as to the accuracy of the reference.

Locality.—St. Doulagh's, county of Dublin.

Orthoceras amabile (?), *L. G. de Koninck.*

1880. Orthoceras amabile, *L. G. de Koninck.* Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., vol. v), pt. 2, p. 57, pl. xxxix, figs. 7, 8; pl. xl, fig. 4; pl. xlii, fig. 3.

1896. — — ?, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland.

. . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 16.

I have identified a specimen from St. Doulagh's with this species with some doubt; it agrees best with de Koninck's figures on pls. xl and xlii of his work. The figure on pl. xxxix, fig. 7, represents a shell with a more rapid rate of tapering than is seen in the figures on the other plates, or in the specimen from St. Doulagh's.

ORTHOCERAS CALAMUS, *de Koninck.*

1880. ORTHOCERAS CALAMUS, *L. G. de Koninck.* Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., vol. v), pt. 2, p. 52, pl. xxxviii. fig. 6.

1896. — — *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 16.

This species is easily recognised by its great length and slenderness, and by its proportionately wide-apart septa. Two specimens have occurred, both of which are from St. Doulagh's, county of Dublin. The most complete of these is 155 mm. in length, 16 mm. at the widest, and 2·5 mm. at the narrowest extremity.

ORTHOCERAS PORTERI, *A. H. Foord.* Plate IV, figs. 1 *a*—*d*.

1896. ORTHOCERAS PORTERI, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 14.

Description.—Shell elongate, slender, tapering at the rate of 1 : 9. Section elliptic, the ratio of the greater to the lesser diameter as 4 : 3. Body-chamber slightly exceeding one-fourth of the entire length of the shell in a specimen of

which the estimated length, including a portion of the apical end, which is broken off, amounts to 385 mm. Septa oblique, 8 mm. apart where the shell has a diameter of about 38 mm., 6 mm. where the diameter is 25 mm. Siphuncle cylindrical, rather wide, central or nearly so. Test perfectly smooth.

Size.—The length of a compressed example which is only preserved up to the base of the body-chamber, and of which the apex is wanting, amounts to 270 mm.; the diameter at the anterior end being 35 mm., at the apical end 13 mm. The body-chamber of another example has anteriorly a diameter of 43 mm., posteriorly one of 36 mm. (Pl. IV, fig. 1 *c*).

Affinities.—The greater distance of the septa from each other, the slower rate of tapering, and the cylindrical siphuncle separate this species from *Orthoceras subclavatum*. From *Orthoceras multistriatum* it is distinguished by its smooth shell, and from *Orthoceras acre* by its much less slender form and less numerous septa. None of the species described by Phillips, M'Coy, and de Koninck approach the present one nearly enough to make a comparison useful.

Remarks.—Crystallisation within the chambers has caused either total destruction of the septa and siphuncle, or their distortion and shifting out of position in a greater or less degree. The section, Pl. IV, fig. 1 *d*, exhibits them with the least amount of displacement.

Mr. James Porter, formerly of Queen's College, Cork, after whom this species is named, gave me much assistance in the Cork district, and I have great pleasure in here thanking him for his kind offices.

Locality.—Little Island, near Cork.

ORTHOCERAS VENABULUM, *A. H. Foord*. Plate IV, figs. 3 *a*—*d*.

1896. ORTHOCERAS VENABULUM, *A. H. Foord*. Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 22.

Description.—Shell rather long, straight, tapering at the rate of 1 : 8. Section elliptic, owing perhaps partly or even entirely to pressure in the rock. Body-chamber long, somewhat less than one-third of the whole length of the shell. Septa slightly oblique, somewhat approximate in the greater part of the shell, but wider apart towards the body-chamber; here, where the shell has a diameter of 50 mm., they are 20 mm. distant from one another. The septal necks are very

short. Siphuncle central, cylindrical, rather wide, but scarcely increasing in width between the septa. Test smooth. The largest example is 520 mm. in length, in which measurement is included a small portion of the extreme apex, which is broken off. The greatest diameter is 65 mm., the least 12 mm.

Affinities.—This species may be distinguished from *Orthoceras acre* by its less slender proportions and wider septa; from *Orthoceras Porteri* by its slower rate of tapering, and more distant and more horizontal septa. None of the Belgian species make any near approach to the one here described.

Remarks.—The interiors of the chambers of the specimens of which sections have been made are filled with calc-spar, which has in some places distorted, and in others destroyed the septa; the siphuncle, however, is intact throughout the whole length of the specimens examined.

Locality.—Clane, county of Kildare.

ORTHOCERAS PERAPPROXIMATUM, *A. H. Foord.* Plate II, fig. 3.

1896. ORTHOCERAS PERAPPROXIMATUM, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 22.

Description.—Shell very small, tapering at the rate of 1 : 5. Section circular. Body-chamber about one-third of the length of the whole shell, therefore long. Septa somewhat oblique, very numerous, about 2 mm. apart. Siphuncle cylindrical, excentric. Test covered with extremely fine, thread-like lines.

Size.—An example in which the greater part of the body-chamber is wanting measures 75 mm. in length; the greatest diameter amounting to 16 mm., the least to 3 mm.

Affinities.—In its closely-set septa this species resembles *Orthoceras cylindraceum*, J. Fleming;[1] it is, however, distinguished from the latter by its more rapid rate of increase, the obliquity of its septa, and the excentricity of its siphuncle.

Remarks.—There is always a certain measure of doubt as to whether very small specimens, such as those here under description, may not have been young

[1] 'Annals of Philosophy,' vol. v, Jan.—June, 1815; 'Observations on the Orthoceratites of Scotland,' p. 199, pl. xxxi, fig. 3. See above, page 7.

shells; but in the absence of a gradational series from young to adult this point would be very difficult to determine. In the present case, at least, I have not been able to identify the form above described with any of the larger species in their young stage of growth, hence there was no alternative but to regard it as a distinct species.

Locality.—St. Doulagh's, near Dublin.

Sub-group *Moniliformes* (*siphuncle moniliform*).

Orthoceras Hindei, *A. H. Foord.* Plate V, figs. 4 *a*—*c*.

1896. Orthoceras Hindei, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 23.

Description.—Shell moderately elongate, straight, tapering rapidly. Section elliptic, this form being due partly to pressure, as it is present in a lesser degree in one of the specimens. The diameters of the ellipse are in the ratio of about 4 : 3. Rate of tapering of the greater diameter estimated for the septate part of the shell 1 : 5. Body-chamber not complete in any specimen; an imperfect one measures 65 mm. in length, is 28 mm. in diameter at its base, and 46 mm. at the anterior end. Septa very concave, oblique to the longitudinal axis of the shell, distant 7 mm. where the larger diameter of the shell measures 27 mm. The siphuncle is large and considerably expanded between the septa, thus presenting a characteristic moniliform appearance. It is markedly excentric in position. Test quite smooth.

Size.—The largest specimen, which is all septate (the extreme apex wanting), measures 200 mm. in length. The other specimens are more or less fragmentary.

Affinities.—The differences which serve to distinguish this species from its congeners, *Orthoceras subclavatum* and *O. pilum*, are not difficult to recognise; the large size of its beaded siphuncle, and its high rate of tapering are sufficient guides, though it must be remembered that the former is not generally to be seen without the aid of the lapidary's wheel.

Remarks.—I have named this species after Dr. G. J. Hinde, F.R.S.

Locality.—Little Island, near Cork.

ORTHOCERAS SUBCLAVATUM, *A. H. Foord*. Plate IV, figs. 2 *a*—*c*.

1896. ORTHOCERAS SUBCLAVATUM, *A. H. Foord*. Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 24.

Description.—Shell rather short, increasing at the rate of 1 : 6. Section elliptic. Ratio of the two diameters 4 : 3. Body-chamber nearly one-third of the length of the whole shell, somewhat fusiform, its base oblique to the longitudinal axis of the shell. Septa oblique, very numerous, about 4 mm. apart where the diameter of the shell is 25 mm. Siphuncle inflated between the septa in a bead-like manner. Shell smooth, its thickness on the body-chamber amounting to about 1·5 mm.

Size.—The length of the only example known amounts to 215 mm.; the greatest diameter to 38 mm., the least to 6 mm.

Affinities.—This species is distinguished from *Orthoceras Hindei* by its more slender form, much closer septa, and smaller siphuncle. From *Orthoceras Bregnii*, de Kon. (not Martin), it differs in its more rapid tapering and wider septation.

Remarks.—This form reminds one at first sight of a *Poterioceras* in the straightness of one side and the curvature of the other, the close and very oblique septa, beaded siphuncle, and the slightly fusiform outline. On the other hand, the almost central position of the siphuncle and the want of any contraction of the body-chamber near the aperture, added to its slender proportions, dispel the idea at first conceived of its affinities.

Locality.—Little Island, near Cork.

ORTHOCERAS PILUM, *A. H. Foord*. Plate V, figs. 3 *a*, *b*.

1896. ORTHOCERAS PILUM, *A. H. Foord*. Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 24.

Description.—Shell straight, somewhat rapidly increasing, the ratio being about 1 : 6. Section elliptic. The ratio of the two diameters nearly as 4 : 3. Body-

chamber unknown. Septa somewhat oblique, deeply concave, somewhat widely separated from one another—that is, 8 mm. apart where the diameter of the shell amounts to 30 mm., 3·5 mm. from each other towards the apical extremity, where the shell measures 15 mm. in diameter. The distance between these two measurements is 75 mm. Test quite smooth.

Affinities.—This species differs from *Orthoceras Hindei* and from *O. subclavatum* by the horizontality of its septa, and it is also distinguished from the former by its smaller siphuncle. Its septa are much wider apart than those of *O. subclavatum*. These differences seemed to justify the distinctness of the present species, of which only one has up to the present time been recognised.

Locality.—Little Island, near Cork.

II. *Group* Annulata.

Orthoceras lævigatum, *F. M'Coy*. Plate V, figs. 1 *a*—*e*.

1843. Orthoceras annulatum, *L. G. de Koninck*. Précis élém. de Géologie, par J. J. d'Omalius, p. 515. (Not of Sowerby.)

1842–4. — dactyliophorum, *L. G. de Koninck*. Descrip. Anim. Foss. Belgique, p. 318, pl. xlvii, fig. 2; pl. xlviii, figs. 7 *a*, *b*.

1844. Cycloceras lævigatum, *F. M'Coy*. Synopsis of the Char. of the Carb. Limest. Foss. of Ireland, p. 10, pl. i, fig. 3.

1850. Orthoceras dactyliophorum, *A. d'Orbigny*. Prodr. de paléont. stratigr., vol. i, p. 113.

1851. — — *C. G. Giebel*. Fauna der Vorwelt, Bd. iii, Abth. 1, p. 255.

1860. Cycloceras lævigatum, *R. Griffith*. Journ. of the Geol. Soc. of Dublin, vol. ix, p. 55.

1880. Orthoceras lævigatum, *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., vol. v), pt. 2, p. 70, pl. xli, fig. 4.

? 1880. Cyrtoceras dactyliophorum, *L. G. de Koninck*. Ibid., p. 30, pl. xxxiv, fig. 1.

1896. Orthoceras lævigatum, *A. H. Foord*. Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 25.

Description.—Shell straight, or slightly curved in the apical region; tapering very slowly, viz. at the rate of 1 : 26. Section circular. Body-chamber

(according to de Koninck) occupying about one-fourth of the total length of the shell; the last portion free from annulations. Septa numerous, slightly oblique, occurring in the centre of the furrows between the annulations, very shallow. Siphuncle small, subcentral. Ornaments consisting of regular, prominent, rounded annulations, undulating as they encircle the shell, almost as strong upon the cast as they are where the test is present. The latter is thin, and is covered with regular transverse lines, somewhat less than 1 mm. apart, so that about eight of them cover the space occupied by one of the annulations and the furrow next to it. In a specimen measured there were in a length of 75 mm. eighteen annulations, six of which occupy, at the narrower part of the shell, 25 mm.

Affinities.—*Orthoceras cyclophorum*, Waagen,[1] from the "Productus Limestone" of the Salt Range in India, resembles the present species very closely, so far as the fragmentary specimens representing it will allow of a comparison being made. The two fragments consist only of three and four annulations respectively. The septa are described as "somewhat oblique," the siphuncle excentric, "removed from the centre a little more than its own thickness." The general aspect of the two forms is strikingly similar, but until more complete examples of the Salt-Range species are found it is no doubt wiser to keep the latter separate from the European species. There is very little resemblance in either of them to *Orthoceras undatum* of Fleming.[2] The latter tapers rapidly (about 1 : 4); the annulations are very numerous, being only 3 mm. apart where the diameter of the shell is from 12 to 20 mm., and they are at a very slightly varying distance from each other. *Orthoceras obliquo-annulatum*, Waagen,[3] is a small fragment exhibiting five or six oblique annulations. It may have been the younger portion of a shell, or, on the other hand, a fragment of a small species. The siphuncle is described as central. Its rate of tapering (about 1 : 18) greatly exceeds that of *Orthoceras lævigatum*, though falling far short of that of *O. undatum*. *Cyrtoceras dactyliophorum*, de Kon.,[4] appears to be only a curved example of the present species; the siphuncle is small, cylindrical, and central, and therefore essentially different from that of *Cyrtoceras*, in which it is large, marginal, and beaded. The curvature is thus the only character which this species has in common with *Cyrtoceras*.

Remarks.—This is a somewhat rare species. I have collected it at Clane and St. Doulagh's, but the specimens figured, kindly lent to me for that purpose by Mr. J. Nolan, of the Geological Survey of Ireland, are from Ardlaman, in the

[1] 'Mem. Geol. Surv. India;' 'Palæontologia Indica,' ser. xiii; Salt-Range Fossils,' vol. i; 'Productus Limestone Fossils,' 1887, p. 68, pl. vi, figs. 7, 8.

[2] 'Annals of Philosophy,' vol. v, Jan.—June, 1815 ("Observations on the Orthoceratites of Scotland"), p. 199, pl. xxxi, fig. 12.

[3] 'Mem. Geol. Surv. India;' 'Pal. Ind.,' ser. xiii, Salt-Range Fossils, vol. i; 'Productus Limestone Fossils,' 1887, p. 68, pl. vi, figs. 7, 8.

[4] 'Calc. Carb. Belg.,' 1880, pt. 2, p. 30, pl. xxxiv, fig. 1.

county of Limerick. They are here for the first time figured, and it may be mentioned that they are the specimens which passed through the hands of de Koninck at the time that he was writing his well-known work on the Carboniferous Limestone of Belgium ('Faune du Calc. Carb.,' &c.). This species is recorded by Sir Richard Griffith in his 'Localities of the Irish Carboniferous Fossils,' arranged as an appendix to M'Coy's 'Synopsis' (1862), from Shrule, near Ballymahon, in the county of Londonderry.

M'Coy's type specimen is in the Museum of Science and Art, Dublin, (Geological Survey Collection).

Localities.—St. Doulagh's, county of Dublin; Clane, county of Kildare; Ardlaman, county of Limerick; Shrule, near Ballymahon, county of Londonderry.

III. *Group* Angulata.

Orthoceras Wrightii, *S. Haughton.* Plate V, figs. 2 *a*—*e*.

1859. Orthoceras Wrightii, *S. Haughton.* On some New Orthocerata from the Carboniferous Limestone of the Neighbourhood of Cork and Clonmel, Journ. Roy. Dublin Society, vol. ii, 1858–9, p. 241, pl. v, fig. 2.

1896. — Puzosianum?, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 26. (Not of de Koninck.)

Description.—Shell rather small, tapering at the rate of 1 : 9. Section very slightly elliptic. Body-chamber incomplete; its proportions cannot, therefore, be given. Septa oblique, making an angle of about 15° with the transverse axis of the shell, shallow; the distance between them cannot be stated, as only the last septum is visible, owing to the body-chamber having become separated from the septate part of the shell. Siphuncle central. The ornamentation consists of numerous (about twenty-four to twenty-seven) longitudinal ribs, strong enough to mark the cast quite distinctly; these are not equally spaced, varying from 1·5 to 2 mm. apart. Between these coarser ribs are four or five finer ones, and over the whole surface of the test are seen innumerable fine and regular transverse lines crossing the ribs and the spaces between them (Pl. V, fig. 2 *c*).

Size.—Length of the Clonmel example 103 mm.; greatest diameter 19 mm., least 6 mm.

Affinities.—This species in its ornamentation roughly resembles *Cyrtoceras Puzosianum*, de Koninck,[1] but it is more elaborate in character in this respect. Thus in de Koninck's species the fine and multitudinous transverse lines are wanting, and there is only one longitudinal ridge between two of the larger ones, —in short, the sculpture is much more simple. De Koninck's species, it may be added, is distinctly curved, hence its assignment to *Cyrtoceras* by its author, for which, however, there appears to be no warrant in the internal structure of the shell.

Remarks.—For a long time *Orthoceras Wrightii* was represented, so far as I am aware, by one specimen only. I have since found an example of it at Clane, which is here figured for comparison with the type specimen. The Clane specimen is not so well preserved as the one from Clonmel, but it nevertheless shows in places all the details of ornamentation which characterise the species. I am indebted to the kindness of my friend Mr. Joseph Wright, F.G.S., of Belfast, for the loan of the type specimen described by Dr. Haughton.

Localities.—Clonmel, county of Tipperary; Clane, county of Kildare.

IV. *Group* Lineata.

Orthoceras Kildarense, *A. H. Foord.* Plate VI, figs. 3 *a*—*d*.

1896. Orthoceras Kildarense, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 26.

Description.—Shell small, straight, tapering at the rate of 1 : 6. Section circular. Body-chamber about one-third of the length of the whole shell. Septa horizontal, distant, being about 7 mm. apart where the diameter of the shell is 15 mm.; varying in distance from 6 mm. to 8 mm. in a length of 32 mm. Siphuncle central, cylindrical. Test covered with exceedingly fine, acute, regular, transverse, thread-like lines, of which eight or nine are contained in the space of 1 mm.; they are therefore scarcely visible without a lens.

Affinities.—This distinct and beautiful species seems to be very rare. I obtained only one example of it, which is now in the Museum of Science and Art,

[1] 'Calc. Carb. Belg.,' pt. 2, p. 34, pl. xxxiii, figs. 10, 11.

Dublin. Another was already in that Collection, and both are figured. The distance of the septa, which is very considerable proportionately to the size of the species, and the character of the ornamentation make this species readily distinguishable from all others. The most nearly related species are the following:—*Orthoceras discrepans*, de Koninck, in which the septa are closer together than they are in the present species; and the ornamentation differs in having two series of transverse lines, the one coarser than the other; while *O. conquestum*, *O. salvum* (described below), and *O. salutatum*, all of de Koninck, have very crowded septa, and the transverse lines ornamenting the surface are distinctly undulating.

Locality.—Clane, county of Kildare.

ORTHOCERAS SALVUM, *L. G. de Koninck.* Plate VI, figs. 4 *a*, *b*.

1880. ORTHOCERAS SALVUM, *L. G. de Koninck.* Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. nat. Belgique, sér. Paléont., vol. v), pt. 2, p. 67, pl. xli, fig. 6.

1896. — — *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 27.

Description.—Shell small, straight, tapering at the rate of 1 : 10. Section slightly elliptic, the ratio of the longer to the shorter diameter being as 5 : 4. A fragment of the body-chamber shows upon the cast a slight constriction near the aperture. Septa numerous, slightly oblique, distant from each other about one-fifth of their own diameter. Siphuncle apparently slightly excentric. Test covered with extremely minute, regular, wavy, transverse lines, eight or nine of which occupy the space of 1 mm. Faint transverse depressions occur at rather regular intervals, giving an appearance of serial arrangement to the lines.

Size.—The most complete specimen obtained is 72 mm. in length (Pl. VI, fig. 4 *a*).

Affinities.—This species resembles *O. discrepans*, de Koninck, in its form, but it is distinguished therefrom by the fineness and the wavy character of its ornamentation. From *O. salutatum* it differs in its more rapid rate of tapering and central siphuncle.

Locality.—Doohyle, near Rathkeale, county of Limerick.

ORTHOCERAS HIBERNICUM, *A. H. Foord*. Plate VI, figs. 1 *a*—*e*.

1896. ORTHOCERAS HIBERNICUM, *A. H. Foord*. Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 28.

Description.—Shell slightly curved in the younger part of it; compressed, making the transverse section elliptic, the ratio of the two diameters being as 7 : 5. Rate of tapering about 1 : 4. Only a fragment of the body-chamber is preserved, so that its form and size cannot be determined. The septa are remarkably numerous, the last two being only 5·5 mm. apart, while in the earlier part of the shell they are about 7 mm. distant, thus conforming to the usual habit of Cephalopod shells in approaching nearer in the vicinity of the body-chamber. Siphuncle rather large, excentric, about its own width from the centre of the septa; lying on the concave side of the curvature of the shell; considerably inflated between the septa. Test very thin; the surface-ornaments consist of numerous fine, longitudinal, parallel, nearly equal, straight, raised but flattened striæ, about three of which occupy the space of 1 mm.; they are therefore visible to the naked eye.

Affinities.—In the closeness of its septa and in its ornamentation this species resembles *Orthoceras pulcherrimum*, but it is easily distinguished from the latter by its much higher rate of tapering, by its rather finer ornamentation, and the excentric position of the siphuncle. From *Orthoceras* (*Actinoceras*) *striatum*, J. Sowerby, it differs by its more rapid rate of increase, much closer septation, and finer ornament.

Remarks.—Only one example of this fine species has hitherto been found; there is therefore no material for the study of the variations to which the species may be subject.

Locality.—Clane, county of Kildare.

ORTHOCERAS PULCHERRIMUM, *A. H. Foord*. Plate VI, figs. 2 *a*—*c*.

1896. ORTHOCERAS PULCHERRIMUM, *A. H. Foord*. Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 29.

Description.—Shell probably elongated, tapering at the rate of about 1 : 9. Section elliptic in the ratio of 6 : 5. Body-chamber incomplete; it shows a well-marked constriction towards the anterior extremity, indicating the proximity of the aperture. The septa are slightly oblique, approximate, and arranged with great regularity. They are 6 mm. distant where the diameter of the shell is 43 mm.; they are therefore about one-seventh of this diameter apart. Only four or five of the septa are seen, as the test covers the rest of the shell. The siphuncle has been destroyed by the deposit of crystalline calcite filling the chambers. It was doubtless cylindrical. The ornaments of the test consist of a multitude of fine longitudinal, parallel, nearly equal, straight striæ, two or two and a half of which occupy the space of 1 mm. When looked at through a pocket-lens of low power, they are seen to be not perfectly straight, but slightly wavy, though they preserve on the whole a very even course, parallel to each other and to the longitudinal axis of the shell. A broad and shallow groove runs the whole length of the specimen; on each side of this groove there is a slight swelling, upon which the transverse lines of growth stand out prominently, the longitudinal ornaments being here scarcely perceptible.

Affinities.—In its ornamentation this species may very well be compared with *Orthoceras* (*Actinoceras*) *striatum* of J. Sowerby,[1] but here the comparison ceases; the septa in the former are twice as numerous as they are in Sowerby's species, the shell is of a more slender habit, and the siphuncle is cylindrical. From *O. lineale*, de Koninck[2] (probably identical with *O. striatum*, J. Sowerby), it is distinguished by the same characters.

Remarks.—The present species is represented only by a fragment (Pl. VI, fig. 2 *a*). Longitudinally striated species are apparently of rare occurrence; only two have come into my hands during five years of collecting in Ireland, and Sowerby's species (from Black Rock, near Cork) makes the third Irish one. The species described by de Koninck under the name of *Orthoceras lineale*, if valid, makes a fourth species. I am not acquainted with any species from the English or Scotch Carboniferous rocks having this kind of ornament.

Locality.—Clane, county of Kildare.

[1] 'Min. Conch.,' vol. i, p. 129, pl. lviii.

[2] 'Calc. Carb. Belg.,' 1880, pt. 2, p. 79, pl. xli; pl. xliii, fig. 8.

V. *Group* Imbricata.

Orthoceras Clanense, *A. H. Foord.* Plate VII, figs. *a*—*g*.

1896. Orthoceras Clanense, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. Inaugural-Dissertation Kgl. bayer. Universität München, p. 33.

Description.—Shell moderately elongate, straight; tapering at the rate of about 1 : 6. Section circular in a fragment of a large adult shell, slightly elliptic in a smaller one, the greater and lesser diameters in the latter being nearly as 6 : 5. Body-chamber slightly fusiform, attaining nearly one-third of the length of the shell; outline of the aperture somewhat undulating, as is also the base of the body-chamber. Septa distinctly oblique (Pl. VII, fig. 1 *c*), the sutures, as seen on the cast of a shell of medium size, making an angle of about 10° with the longitudinal axis of the shell. Chambers very concave, moderately deep, about four times as wide as they are high. Siphuncle slightly excentric, beaded in the young shell, as seen in a natural fracture of the apical part of a specimen (Pl. VII, fig. 1 *g*), but tending to become cylindrical as the shell increases in size. Test varying in thickness from ·75 mm. to 1·5 mm., the thickest part being upon the body-chamber of the adult shell. Surface ornamented with multitudinous, fine striæ, imbricating upwards; these are generally arranged with great regularity over the surface of the test, this regularity being only here and there a little disturbed by the striæ being more crowded together. Thus, for the most part, four of the striæ may be counted in the space of 1 mm., but in some places not more than two. But on the body-chamber of an adult shell the striæ are 1 mm. apart. Towards the middle of the body-chamber of the adult shell the striæ become wider apart, and generally disappear before the aperture is reached, leaving the shell quite smooth.

Size.—The length of the most complete specimen is 255 mm., the body-chamber being nearly perfect, but the apical part broken (Pl. VII, figs. 1 *a*, 1 *b*). The greatest diameter of this specimen is 57 mm., the least 22 mm. A large fragment collected measures 220 mm. in length, with a diameter at the posterior end of 70 mm. and at the anterior end of 85 mm. This specimen consists of part of the body-chamber and a few of the septa, with portions of the test attached. It is in the Museum of Science and Art, Dublin.

Affinities.—A species named by de Koninck[1] *Orthoceras vicinale*, of which only part of the body-chamber was known to the author, came under my notice at Brussels. A comparison with the Irish form showed a general similarity in the ornamentation, but as this is the only character available for comparison I do not feel justified in uniting the two forms upon this ground alone. De Koninck's *Orthoceras Morrisianum*, which that author describes from specimens found at Visé, Belgium, and alleges to have been found at Rathgillen and Kilgrogan in the county of Limerick, has an ornamentation consisting of very fine thread-like lines, about their own width apart, and which towards the anterior part of the body-chamber divide into two or three finer lines between coarser ones. These are manifestly different from the imbricating lines ornamenting the shell of *Orthoceras Clanense*. The two species are also distinguished by the position of the siphuncle and the direction of the sutures, oblique in *O. Clanense*, horizontal in *O. Morrisianum*. I examined a specimen of the latter in the Brussels Museum, and I think I recognise this species in a fragment in the Museum of Science and Art, Dublin, from Kilgrogan (Limerick), whence Baily's figured specimen named *Orthoceras cinctum*[2] came. The latter, drawn in a very sketchy manner, is not described, and I have not been able to find the original. The figure, however, indicates a form with a slower rate of increase and much closer septa than *Orthoceras Clanense* has. It may possibly be referable to *O. Morrisianum*.

Remarks.—This fine species will recall some similar forms figured by Barrande ('Syst. Sil. de la Bohême'). The ornamentation makes it easily recognisable. It is not very rare in the Clane quarries, but I have not met with it anywhere else.

Locality.—Clane, county of Kildare.

[1] 'Faune Calc. Carb. Belgique' ('Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont.,' vol. v), pt. ii, p. 69, pl. xlv, figs. 3, 3 *a*, 3 *b*.

[2] 'Figures Char. Brit. Foss.,' vol. i, Palæozoic, 1867–75, pl. xl, figs. 8 *a*, 8 *b*.

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MONOGRAPH

ON THE

CARBONIFEROUS CEPHALOPODA

OF

IRELAND.

BY

ARTHUR H. FOORD, Ph.D. (Münch.), F.G.S.

PART II.

CONTAINING THE FAMILIES

ORTHOCERATIDÆ (concluding Part), ACTINOCERATIDÆ, CYRTOCERATIDÆ, and POTERIOCERATIDÆ.

Pages 23—48; Plates VIII—XVII.

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ORTHOCERAS SOLLASI, *A. H. Foord.* Plate VIII, figs. 1 *a—f.*

ORTHOCERAS SOLLASI, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 32.

Description.—Shell straight, of medium size, tapering at the rate of 1 in 8. Section slightly elliptical, the ratio of the two diameters as 37 : 32. Body-chamber of moderate size, about one-fourth the length of the shell; edge of the aperture undulating; below it on the cast there is a well-defined shallow, crescentic depression, which at each extremity of the longer axis of the shell is 10 mm. below the edge of the aperture, from whence it passes down and forms a shallow sinus on the broader aspect of the shell. Septa deeply concave, horizontal, distant from each other about two-fifths of their own diameter. Siphuncle cylindrical, about one-eighth the width of the shell; nearly central. The surface of the cast, where it is well preserved, shows admirably the fine "wrinkles" and minute punctures described by the Brothers Sandberger under the name of "Runzelschicht" ('Die Verstein. Nassau,' 1856), which have been ascribed to the markings on the mantle of the animal preserved through the medium of the extremely fine sediment which filled the body-chamber, and sometimes too the septate parts of the shell after the death of the animal, but before the decay of the soft parts. The ornaments in this specimen are very conspicuous; they consist of fine imbricating striæ, disposed with great regularity, the edges of the imbrications being directed towards the aperture. Four of them occupy the space of 1 mm.; they are therefore visible to the naked eye, at least in the older parts of the shell (Pl. VIII, fig. 1 *c*, natural size, and giving nearly the number of striæ of the part figured).

Size.—The most complete specimen, wanting only a portion of the apical end, measures 190 mm. in length, the diameter at the apertural extremity being 35 mm., that at the apical one 13 mm.

Affinities.—This species is closely related to *Orthoceras Clanense*, and the question naturally arose as to whether it might not have been the young of that form. There are, however, some points which weigh against this supposition: chief among these is the rate of tapering, which is much quicker in *O. Clanense* (1 : 6) than in the present species (1 : 8); further, the septa in *O. Sollasi* are horizontal, while they are oblique in *O. Clanense*. The ornaments, though finer in *O. Sollasi* than in the latter species, are the same in character in both,

and constitute the main and obvious feature in the relationship of the two forms.

Remarks.—The occurrence in the Clane quarries of several examples of this beautiful form, all stamped with its characteristic features, impart the requisite stability to it as a species. Two of the best specimens are figured, the test being exquisitely preserved in the one represented by fig. 1 *a*; in the other (fig. 1 *e*) the surface is considerably eroded, though the strength of the markings has preserved them here and there from complete destruction, and thus the identity of the species has not been lost. I regret that the apical end is not present in any of the specimens before me. Most of the fossils which come into the hands of the palæontologist have already suffered from the effects of the sledge-hammer of the quarryman, whose untrained eyes allow these valuable pieces to remain embedded in the rock, and thus many a precious fragment is thrown aside or shot into the fiery depths of the lime-kiln! The species is named after Professor W. J. Sollas, F.R.S., of Oxford.

Locality.—Clane, county of Kildare.

ORTHOCERAS MULTISTRIATUM, *A. H. Foord.* Plate VIII, figs. 2 *a*, *b*.

ORTHOCERAS MULTISTRIATUM, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 31.

Description.—Shell straight, elongate, tapering at the rate of 1 : 10, measured along the larger diameter. Section somewhat elliptical, whether naturally so or by rock-pressure it is difficult to determine; the ratio of the two diameters is as 38 : 30. Body-chamber imperfect, so that its size in relation to the complete shell cannot be computed. Septa oblique, 8 mm. apart where the diameter of the shell stands at about 20 mm.; necks of the septa short and hooked. Siphuncle cylindrical and rather wide (Pl. VIII, fig. 2 *b*). Test ornamented with fine, irregularly spaced, imbricating striæ, the edges of which are directed upwards; about two of the striæ fill the space of 1 mm., they are therefore visible to the naked eye (Pl. VIII, fig. 2 *a*).

Size.—The length of the most complete specimen known to me is about 195 mm., the greatest diameter 40 mm., the least 18 mm.

Affinities.—The ornamentation of this species naturally suggests affinities with *O. perellipticum*, but the general form is quite different, the rate of tapering being very low in the present species and very high in *O. perellipticum*. While thus

agreeing in the character of its ornamentation with the latter, *O. multistriatum* is in its shape and septation more akin to *O. Sollasi*, from which, however, it separates itself by its much finer ornamentation and larger siphuncle. On the whole it is a fairly well-marked species. It has been found up to the present time only in the Cork district.

Locality.—Little Island, near Cork.

ORTHOCERAS PERELLIPTICUM (*A. H. Foord*), *F. M'Coy*. Plate VIII, figs. 3 *a*—*c*.

1844. ORTHOCERAS (LOXOCERAS) DISTANS, *F. M'Coy*. Synopsis of the Char. of the Carb. Limest. Foss. of Ireland, p. 8, pl. iv, fig. 1 (not of Sowerby).

1888. — PERELLIPTICUM, *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 1, p. 104.

1896. — — (*A. H. Foord*), *M'Coy*. Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 30.

Description.—Shell of medium size, straight, rate of increase rapid, being at the rate of 1 : 5. Section elliptic, the ellipticity probably at least in part caused by rock-pressure; the proportion of the two diameters in the type specimen as 12 : 8. Body-chamber unknown. Septa undulating, rather widely separated (hence M'Coy's name), distant from each other 6 mm. where the diameter of the shell is 18 mm., the space between them increasing to 8 mm. where the diameter of the shell is 26 mm. Siphuncle central or nearly so (Pl. VIII, fig. 3 *b*), its structure unknown. Shell thin, ornamented with very fine, upwardly imbricating striæ, arranged with approximate regularity, running obliquely across the surface of the shell. Six or seven of these striæ occupy the space of 1 mm. When highly magnified (Pl. VIII, fig. 3 *c*) they are seen to be of unequal size, though their general aspect when looking over the surface of the shell with a hand-lens gives the impression of their being fairly regular.

Affinities.—Its elliptical form and high rate of tapering enable this species to be readily distinguished from *O. multistriatum*. These features exist in all specimens to which I have had access, including the type specimen contained in the Dublin Museum of Science and Art (Griffith Collection), and others in the general collection in that museum; also the one figured, which is from the museum of Queen's College, Cork. It is easily distinguished from *O. Clanense* and *O. Sollasi* by its much finer sculpture, added to the characters mentioned above.

Remarks.—I have not refigured the type specimen because it is almost entirely denuded of the test, owing to which circumstance M'Coy overlooked the striations upon its surface; these are, however, actually preserved upon a fragment of the test to which my attention was drawn by my friend Mr. G. C. Crick, of the British Museum. But for this fortunate discovery it would not have been possible to identify M'Coy's species with any other form without much uncertainty. Owing to M'Coy's *O. distans* being preoccupied by J. de Carle Sowerby (in Murchison's "Silurian System," p. 619, pl. viii, fig. 17), I was compelled to re-name the present species when describing it in the 'Catal. Foss. Cephal. British Museum' (1888, pt. 1, p. 20).

Locality.—Little Island, near Cork.

[Orthoceras cinctum, *J. de Carle Sowerby.* Min. Conch., vol. vi, 1829, p. 168, pl. dlxxxviii, fig. 3.

Orthoceras cinctum, *A. H. Foord,* 1896. Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 37.

The original of this species, which should be in the "Sowerby Collection" in the British Museum, has been lost, and there is therefore only the author's brief description and accompanying figure by which to identify it. Sowerby's description is as follows: "Shell nearly cylindrical, surface ornamented with numerous sharp, annular striæ; siphon central. In this species the septa are rather more concave than is usual, and also distant. The transversely striated surface is what it is best distinguished by, and seems to indicate a shell formed outside the animal. I have seen but one specimen. . . . . Near Preston, Lancashire."

The short description given by Sowerby, and the sketchy character of his figure, make any attempt to identify *O. cinctum* with actual specimens a very risky matter, considering that several species ornamented with striæ of different kinds can now be identified from England, Scotland, Ireland, and Belgium.

The appearance, therefore, of the name "*Orthoceras cinctum*" in lists of fossils cannot be taken as in any way authoritative for the occurrence of Sowerby's species in the particular locality indicated, since we are ignorant as to what that species is. Caution in this case is all the more necessary since it was not formerly the practice to examine minutely into the character of the ornamentation upon

the surface of such shells, and apparently no distinction was made between what are properly termed "imbricating" lines and other fine transverse lines of a totally different nature.

I would suggest, therefore, that the name "*Orthoceras cinctum*" be given up, since its further employment can only lead to confusion.]

B. Brevicones.

Orthoceras perconicum, *A. H. Foord*. Plate VIII, figs. 4 *a*, *b*.

1896. Orthoceras perconicum, *A. H. Foord*. Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 36.

Description.—Shell abruptly conical; rate of tapering very rapid, that is about 1 : 2. The transverse section is slightly elliptical, the proportion of the two diameters being as 35 : 29. The body-chamber is very large, occupying fully half the length of the entire shell, and far exceeding it in bulk. Only the sutures are seen, the septa themselves, as a section proved, having been completely destroyed; they are perfectly horizontal. The siphuncle is not preserved. The only example obtained measures 86 mm. in length; the greater diameter amounts to 47 mm., the lesser to 16 mm. (this is considerably above the apex). The test is perfectly smooth.

Size.—Length (imperfect at both ends) 86 mm.; greatest diameter 47 mm., least 16 mm.

Affinities.—In seeking for a species related to the present one, that described by de Koninck from Visé, Belgium, under the name of *Orthoceras cucullus*[1] at once presents itself to our notice. This consists only of the chambered part of the shell, so that the proportions of the body-chamber in relation to the complete shell cannot be compared with those of *O. perconicum*. The rate of increase in the diameter of the Belgian species is 1 : 2·66; that of the Irish species, as indicated above, 1 : 2. The sutures are rather wider apart in *O. cucullus* than they are in *O. perconicum;* that is, in an interval of 28 mm., measured off at the smaller end of each specimen, there are five chambers in the latter against four and a half in the former. Both species are unfortunately only imperfectly known. In *O. cucullus* the body-chamber and the test are wanting, in *O. perconicum* the siphuncle and the septa (not their sutures) have been destroyed. There are thus

[1] 'Descrip. Anim. Foss. Belg.' (Suppl.), 1851, p. 54, pl. lix, fig. 1.

two elements of difference between these species, viz. the rate of increase and the width of the intervals between the sutures.

This may be regarded as a very rare species, only one specimen having been found in the course of several years of collecting.

Remarks.—The group of forms to which Barrande[1] gave the name "*Orthocères brévicones*" are rare in the Carboniferous rocks. I am only acquainted with three European species, viz. *O. dilatatum*, de Kon.,[2] *O. cucullus*, de Kon.,[3] and *O. perconicum*, Foord. The other Carboniferous species assigned by Barrande to the brevicone group prove to be species of *Poterioceras;* these are "*Orthoceras*" *cordiforme*, J. Sow., and "*O.*" *latissimum*, Portl. The latter was even suggested by its author to be "*O.*" *cordiforme*, its condition being too imperfect to admit of certainty as to its true position. I shall have occasion to refer to this fragment again later on.

Family Actinoceratidæ.

Genus Actinoceras, *Bronn*, 1837.

Actinoceras giganteum, *J. Sowerby*, sp. Plate IX, figs. 2 *a*—*c*.

1821.	Orthocera gigantea, *J. Sowerby*.	Min. Conch., vol. iii, p. 81, pl. ccxlvi.
1836.	Orthoceras giganteum, *J. Phillips*.	Geol. of Yorkshire, pt. 2, p. 237, pl. xxi, fig. 3.
1840.	Actinoceras Simmsii, *C. Stokes*.	Trans. Geol. Soc., ser. 2, vol. v, pt. 3, p. 708, pl. lix, figs. 4, 5.
1843.	— — *J. E. Portlock*.	Rep. on the Geol. of Londonderry, &c., p. 391.
1844.	Orthoceras giganteum, *L. G. de Koninck*.	Descrip. Anim. Foss. Belg., p. 510, pl. xliv, fig. 2; pl. xlv, fig. 3; pl. xlvi, and pl. xlvii, fig. 1.
1844.	Actinoceras giganteum, *F. M'Coy*.	Synop. Carb. Foss. Ireland, p. 11.
1844.	— pyramidatum, *F. M'Coy*.	Ibid., p. 11, pl. i, fig. 5.
1854.	— giganteum, *F. A. Roemer*.	Beitr. z. geol. Kenntn. des nordwest. Harzgeb., Palæontographica, Band iii, p. 93, pl. xiii, figs. 27 *a*—*c*.
1855.	Orthoceras (Actinoceras) giganteum, *F. M'Coy*.	British Pal. Foss., fasc. 3, p. 571.
1862.	Actinoceras giganteum, *R. Griffith*.	Journ. Geol. Soc. Dublin, vol. ix, pp. 33 and 55.
1874.	— — *J. Young and J. Armstrong*.	Trans. Geol. Soc. Glasgow, vol. iv, p. 280.

[1] 'Syst. Sil. de la Bohême,' vol. ii, p. 18.

[2] 'Descrip. Anim. Foss. Belg.,' 1842–4, p. 515, pl. xlv, figs. 8, 9.

[3] Idem, Suppl., 1851, p. 54, pl. lix, fig. 1.

1880. Orthoceras giganteum, *L. G. de Koninck*. Faune Calc. Carb. Belg., tom. v, p. 75, pl. xliv, figs. 5—10.

1888. Actinoceras giganteum, *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 1, p. 187.[1]

Description.—Shell very large, straight. Section nearly circular. Rate of increase varying from 1 : 7 to 1 : 5. Septa moderately convex, somewhat oblique in the upper part of the shell, increasing somewhat rapidly in their distance apart; for example, in a specimen measuring 850 mm. in length the septa are only 2 mm. (about) distant at the smaller extremity, while at the larger the interval between them has increased to 25 mm. There is a large fragment contained in the Museum of Science and Art, Dublin, from the red limestone of Castle Espie, county of Down, which has the following dimensions: length 750 mm., greatest diameter 280 mm., least 155 mm. Another specimen, collected by myself at Clane, in the county of Kildare, has a length of 910 mm., the greatest diameter being 240 mm., the least 35 mm.; this gives a rate of tapering of about 1 : 4·5. The distance of the last three septa from each other is from 40 to 50 mm., that of those at the smaller end (where the diameter is 55 mm.) from 11 to 12 mm. The length of the portion of the body-chamber preserved is 240 mm. The specimen is chemically eroded, the surface roughened and destroyed, and showing no trace of the test. The siphuncle is not large in proportion to the size of the shell; it is a little excentric in position in the young shell, tending to become more nearly central in the adult; it is much inflated between the septa, where it forms depressed spheroidal segments twice as wide as long. The outer surface of the test is generally wanting, and the inner layer being quite smooth has led to the species being described as having a perfectly smooth shell. There is a specimen, however, in the British Museum which has a distinctly striated surface above the smooth layer, the ornaments consisting of fine transverse lines, of which there are about three in the space of 2 mm.[2]

Affinities.—The only species with which the present one may be compared is that next to be described, and the characters separating the two species being enumerated under the latter, it is not needful to mention them here.

Remarks.—Of the records of this species in foreign localities of the Carboniferous rocks only two need be referred to, viz. that of de Koninck and that of Roemer. The former of these authors has described and figured the species in his well-known work on the Carboniferous fauna of Belgium, where it occurs in several localities. The latter has figured and very briefly described a fragment from the Kulmkalk of Grund, in the Hartz Mountains ('Palæontographica,' 1854,

[1] The list here supplied gives only the more important synonyms and references; it does not claim to be exhaustive.

[2] The specimen showing these markings is registered C 325 in the collection.

Band iii). The species occurs in several places in the British Isles, chief among which are Closeburn in Dumfriesshire (the locality whence Sowerby's type was obtained), and Castle Espie, county of Down, where specimens of this rather common species occur of such a size as fully to justify the name given to it by Sowerby. It has been found also at Orchard, near Glasgow, and at Bolland in Yorkshire.

The specimens of *A. giganteum* yielded by the Carboniferous rocks of Belgium present the same differences when compared with *A. insulare* as do those of Scotland and Ireland, of which the closer septa in the Belgian form is the most important one. To this must be added the striated test described above, whose presence might seem to have been strangely overlooked among the many specimens of this form passing through the hands of palæontologists. I have not observed the test, however, upon any of the specimens from Closeburn or Castle Espie, whence most of the specimens to be seen in museums have come. It is not so astonishing, therefore, that it should all along have been supposed that the species had a smooth shell.

I am indebted to the kindness of Prof. J. Joly, F.R.S., for the use of some examples of this species from the museum of Trinity College, Dublin. These show the structures of the siphuncle remarkably well, considering the highly crystalline condition of the rock in which they are preserved (Pl. IX, figs. 2 *a*—*c*).

Locality.—Castle Espie, county of Down (specimens figured). Other localities are mentioned above.

ACTINOCERAS INSULARE, sp. nov. Plate X, figs. 1 *a*—*d*.

Description.—Shell (fragment) large, straight. Section elliptical, at least in the lower half of the specimen, the ratio of the two diameters here being as 58 : 48. Rate of increase about 1 in 7. Septa very concave, increasing rather rapidly in their distance apart; that is, at a place where the diameter of the shell is 58 mm. they are 17 mm. apart, and where this has increased to 125 mm. they are 35 mm. distant. The length of the portion of the shell thus measured is 260 mm., out of a total length of 345 mm. for the whole fragment. The septa are strongly oblique in the upper part of the shell, where they have been exposed by the accidental removal of the test in breaking the rock away from the shell; in the lower half they cannot be seen, as the test is there preserved and covers them. Their obliquity makes an angle of about 20° with the horizontal axis of the shell. The siphuncle is well seen in longitudinal (polished) sections (Pl. X, fig. 1 *d*), and its position is also indicated on the convex surface of the smaller end of the specimen (Pl. X, fig. 1 *b*). It forms, as usual with *Actinoceras*, sac-

like swellings between the septa, and is traversed through the centre by the endosiphuncle, whose radiating tubuli are given off circumferentially from these swellings (Pl. X, fig. 1 *d*). The siphuncle is somewhat compressed laterally, perhaps through partial collapse, though it would be naturally less inflated than in species having closer septa. Its outline, seen in section, is only slightly inflated, so as to make each segment of it a little higher than wide. The necks of the septa are distinctly seen in several places (Pl. IX, figs. 1 *c*, *d*; Pl. X, fig. 1 *d*), and in some places the perforations in the walls of the siphuncle (at the second tubule from the bottom of the figure, Pl. X, fig. 1 *d*; the perforation is not indicated in the drawing). The position of the siphuncle is markedly excentric, being about two-fifths across the shorter diameter of the shell, measured to the centre of the siphuncle; it is also not quite central in relation to the longer diameter. Its position may be best realised by looking at the figure (Pl. X, fig. 1 *c*). The test is perfectly smooth.

Size.—Length of the fragment 345 mm.; greatest diameter 120 mm., least 45 mm.

Affinities.—The fragmentary condition of the only example of this species known to me up to the present time makes the question of its relationship with other species a difficult one to settle. If the external characters are examined the differences observed between the present species and *Actinoceras giganteum* are found to consist in the smoothness of the test, the much greater width of the septa, and the more compressed character of the segments composing the siphuncle in the former as compared with the latter. In *A. insulare* the septa are 16 mm. apart where the diameter of the shell is 58 mm., whereas in a specimen of *A. giganteum* from Orchard, near Glasgow, the septa, at the same diameter of the shell, are only 13 mm. apart; or, measuring in another way, three chambers of the Cork species require 43 mm. to span them, while in the Scotch specimen only 34 mm. are necessary. The diameter of the shell for this measurement is the same in both cases, viz. from about 50 mm. up to 58 mm. It would appear also that the position of the siphuncle is more nearly central in *A. giganteum* than it is in the present species.

The obliquity of the septa, which is so strongly marked in *A. insulare*, is not unknown in *A. giganteum*, and I find a reference in my note-book to a specimen in the British Museum coming from Ireland in which this feature is well developed. On the other hand, in the Belgian examples figured by de Koninck ('Faune Calc. Carb.,' v, pl. xliv) the septa are perfectly horizontal. Reliance could not, therefore, be placed upon this character alone in distinguishing the two species, as it seems to be one that is subject to variation.

Remarks.—Attention should be directed still more particularly to the flatness of the outline of the siphuncular segments in *A. insulare* as compared with

A. giganteum, in which they are strongly inflated or bulbous (cf. Pl. IX, fig. 2 *c*, with Pl. X, fig. 1 *d*). The greater width between the septa in *A. insulare* may have caused the segments to be more drawn out, and thus to approach the cylindrical form which they must have assumed if this process had been carried still farther; whether, however, this would have been compatible with the existence of the endosiphuncle and its appendages is questionable, since it is evident that the development of these organs could not have taken place within a very contracted space. It is at least certain that in such a form as *A. insulare* there could not have been developed so great a number of tubules as are indicated by the perforations in such a form as *Actinoceras Bigsbyi* (cf. 'Cat. Foss. Ceph. British Museum,' 1888, vol. i, p. 164, fig. 21).

I may take the opportunity before leaving the subject of the structure of *Actinoceras* to refer to an important contribution to the literature of the fossil Cephalopoda by Prof. Hyatt, viz. his "Phylogeny of an Acquired Characteristic" ('Proc. Amer. Phil. Soc.,' vol. xxxii, No. 143, August, 1894). Under the heading "Ontogenetic Stages," in which the embryology of the group is very fully discussed, some important observations are made with reference to the siphuncle of *Endoceras*, *Piloceras*, and *Actinoceras*, and justification is found for the use of the term endosiphon (or endosiphuncle), to which F. A. Bather, in his able critical summary of recent views and discoveries ("Cephalopod Beginnings," 'Natural Science,' vol. v, December, 1894), takes exception. The following extract from Hyatt's memoir has a direct bearing upon the subject:—"The structure of the apex in *Endoceras*, *Piloceras*, and *Actinoceras* indicates large and direct, open, tubular connection between the protoconch and the animal when in this first chamber through which the endosiphuncle in the generalised Nautiloids, Endosiphonoidea, opened into the protoconch. The tubular opening of the apex in *Endoceras*, *Piloceras*, and *Actinoceras*, and other genera having a marked endosiphuncle, is not closed by the cæcum of the siphuncle as was formerly supposed. It is, on the contrary, directly continuous with the endosiphuncle, as was first pointed out by Foord in his 'Catalogue of Fossil Cephalopoda in the British Museum,' part 1, 1888, p. 165. This is an attenuated, central, more or less irregular tube or axis formed by the extension of the points of successive endocones or sheaths. It is more or less interrupted by pseudo-septa, and is a separate and distinct part occupying the axis of the large siphuncle. This organ is continuous with some corresponding part in the embryo which existed in the protoconch. On the other hand, the true siphuncle, including the cæcum of the first air-chamber, is a secondary organ formed by the funnels of the septa."

The "endocones or sheaths" and "pseudo-septa" referred to by Hyatt in the above quotation do not occur in *Actinoceras* or its congeners, but the analogy between the inner tube in the siphuncle of the latter and that which is found in

Endoceras and *Piloceras* is too clear to be doubted. Whether their functions were alike is quite another question. Of the functions of the radiating tubuli given off by the endosiphuncle of *Actinoceras*, which are not present in *Endoceras* or in *Piloceras*, the explanation suggested by Owen seems a very rational one, viz. that they served for the passage of blood-vessels to the lining membrane of the air-chambers. They also afforded support to the endosiphuncle, and held it in its central position in the siphuncle.

Locality.—Little Island, near Cork.

ACTINOCERAS PROPINQUUM, sp. nov. Plate IX, figs. 1 *a*—*e*.

This is a fragment of the septate part of a rather slowly tapering species (1 in 7). The septa are deeply concave and wide apart, varying very little in their distance as the shell increases in diameter. The necks are recurved. The siphuncle, which is badly preserved, is composed of somewhat flattened elements (cf. *A. insulare*), with the endosiphuncle indistinctly seen as a dark patch running through the centre of the tube, having obscure indications of the characteristic tubuli. The position of the siphuncle is decidedly excentric (figs. 1 *c*—*e*). The test is perfectly smooth.

Remarks.—Though I originally intended to include the fragmentary form here referred to in *Actinoceras insulare*, I have since decided that it is better to keep them separate despite their resemblance. This consists in the character of the septa and siphuncle; in both species the former are relatively wide apart, and in both the elements of the siphuncle are compressed as seen in section (Pl. IX, fig. 1 *c*; Pl. X, fig. 1 *d*). The complete horizontality of the septa, however, in the present form, and its apparently more slender habit, caused me to hesitate about uniting the two forms without having more satisfactory material than the fragment here described provides.

Locality.—Little Island, near Cork.

Family CYRTOCERATIDÆ.

CYRTOCERAS (MELOCERAS) APICALE, sp. nov. Plate XI, figs. 1 *a*, 1 *b*, 2 *a*, 2 *b*, 3; Plate XII.

? 1854. ORTHOCERAS UNGUIS, *Haughton*. Journ. Geol. Soc. Dublin, vol. vi, p. 48, pl. —, fig. 3 (not of J. Phillips).

Description.—Shell of moderate size, rather sharply curved in the lower third of the septate portion, but becoming almost straight above this, so that a frag-

ment consisting only of the upper two-thirds of the shell would scarcely exhibit any curvature. Upon a chord of 38 mm. subtending the concave side of the apical region of the shell the greatest curvature is 5 mm. The rate of tapering above this curved part is about 1 : 4, which is a rapid increase in diameter. The section is very nearly circular, the siphuncle close to the margin of the outer curvature of the shell. The body-chamber considerably exceeds one-third of the length of the entire shell; its basal line is indicated by the letters *a*, *b*, in fig. 2 of Pl. XII, in which its obliquity is very marked, making an angle with the horizontal axis of the shell of about 18°. The septa are numerous, and being tilted up in a ventro-dorsal direction the sutures have a strong obliquity on the sides of the shell, while they are nearly horizontal on the ventral and dorsal aspects, perhaps with a slight arching upwards on the dorsal aspect (Pl. XII, figs. 1 *a*, 1 *b*). The distance between the sutures in an adult shell (Pl. XII, fig. 1 *b*), where the diameter is about 50 mm., is from 5 to 6 mm.; in a somewhat smaller example (Pl. XII, fig. 3) the sutures are 4 mm. apart where the diameter is 15 mm., 6 mm. apart where it is 37 mm. In a smaller specimen (Pl. XI, figs. 2 *a*, 2 *b*), which is entirely septate, there are twenty-two septa within a distance of 106 mm. The chambers must thus have been very shallow. Exactly in the median line of the ventral aspect, or outer curvature of the shell, there is a straight thread-like line or keel, feebly developed, but clearly perceptible when the surface of the cast has not been abraded; it is represented rather too broad in the figure (Pl. XII, fig. 1 *b*). The siphuncle is exogastric,—that is, it is situated close to the convex or ventral border of the shell; it is strongly inflated in passing through the chambers (Pl. XII, figs. 3, 4 *a*, 4 *b*), casts of it presenting the characteristic bead-like appearance as in the last figures referred to.

The surface of the shell is perfectly smooth.

Size.—The approximate measurements of the most complete specimen give length 190 mm., greatest diameter of body-chamber 53 mm., diminishing to 48 mm. at or close to the aperture, and 6 mm. near the apical extremity.

Affinities.—There can be no doubt that *Cyrtoceras rostratum*, de Koninck,[1] is closely related to the present species. Both forms have quickly tapering, thick shells, with the curvature most marked in the apical region. The distinguishing characters are found chiefly in the septa, which are strongly oblique in *C. apicale*, while they are only very slightly so in *C. rostratum*. The section also in the latter species is distinctly oval (cf. de Koninck, Pl. xxxv, fig. 1 *b*), while it has been shown to be almost circular in the former. The oval form of the section in de Koninck's species is brought out in his figures, in which the narrow ventral aspect is in strong contrast with the much broader lateral one. The section gives a

[1] 'Faune Calc. Carb. Belg.,' 1880, tom. v, p. 26, pl. xxxv, figs. 1, 2.

dorso-ventral diameter of 42 mm., and a lateral one of 38 mm. The position of the siphuncle is the same in both species.

Of other species described and figured by de Koninck, *C. cornu* is a more slender shell and has a stronger curvature than the present species. *C. digitus* is nearer to *C. apicale*, but it tapers much more slowly; a fragment only is figured by de Koninck: the species has been identified by him from Rathkeale, near Limerick. Fragments named by de Koninck *C. hircinum*, *C. impotens*, *C. Nysti*, *C. ignotum*, *C. concinnum*, and others, must be passed over, as they are too imperfect to make a comparison with the present species in any way satisfactory.

Remarks.—It is always instructive to consult the pages of Barrande's great work on the fauna of the Bohemian basin, and to study in the rich illustrations to it the varying forms assumed by such an extensive group as the Cyrtoceratidæ, especially during the period of its greatest development—the Silurian.

The most striking differences between the present species, which may be taken as typical of the Carboniferous development of the group under consideration, and the Silurian (Étage E of Barrande) forms described by Barrande, are to be recognised in the relative dimensions of the body-chamber, and in the septation. Beginning with the first of these characters, it is found that the body-chamber in the Silurian species is generally small, sometimes excessively so, relatively to the size of the shell; it is often less than one-fourth, sometimes even less than one-fifth of the whole length of the shell (cf. Barrande, 'Syst. Sil. Boh.,' ii, pl. cviii, *Cyrt. æquale*, pl. cx, *C. miles*, pl. cxviii, *C. acinaces*). The septa are, as a rule, crowded together to the utmost extent (cf. Barr., pl. cxxxii, *C. nescium*, pl. cci, *C. Scharyi*), indicating a remarkable rapidity of growth in the animal that secreted them. Turning to the siphuncle, it is observable that the beaded character is, in the main, the prevailing one, though this is modified in form by the curvature of the shell, the position of the siphuncle therein, and the width apart of the septa. Some of the modifications assumed by the siphuncle are well illustrated in pls. cxxxiv to cxxxviii of Barrande's work. There are not wanting also types in which the siphuncle is cylindrical, as in the living Nautilus, while there are transitional forms from these to the most inflated kinds (cf. Barr., pl. cix, cxx—cylindr.; pls. cxxvi, cxxviii—transit.; pls. cxxxv, cxlii—inflated).

Of the Devonian species of Cyrtoceras it may suffice to say that their affinities lean more in the direction of their Silurian progenitors than in that of their successors in the Carboniferous period. The Devonian rocks have not yielded very numerous examples of this type either in Europe or in America, but the different forms it assumes are fairly well represented. Thus we have the short, thick, and quickly increasing shell, exemplified in the Eifelian species *C. depressum*, Goldf., the type of the genus; and in contrast with this the slender, beautifully ornamented forms found in the typical rocks of Devon (cf. G. F.

Whidborne, 'Devonian Fauna of the South of England,' Palæontographical Society, 1890, vol. for 1889, and similar forms ornamented with frill-like lamellæ in North America (cf. James Hall, 'Palæont. New York,' 1879, vol. v, part 2). In all these, certain characters recalling the Silurian forms are to be traced; these are the numerous septa and marginal siphuncle, sometimes exogastric, sometimes endogastric, the highly ornate shell being perhaps the only distinguishing mark that can be applied to them as a group.

The Carboniferous species, so far as they are known, present, on the whole, a more simple type of structure than that of their Silurian ancestors as represented in the rich series of forms found in the Bohemian basin. The shells are generally more rapidly tapering and less strongly and uniformly curved, and the septa much less numerous in the Carboniferous species, which thus represent a generalised type in which the features that distinguished the ancestral forms have become greatly modified.

The tendency in this expiring race to a more simplified structure is still more strongly exemplified in the species to which I have given the new name *Eusthenoceras*, a passage form, in all that relates to the structure of the adult shell (the embryo is not known), from *Orthoceras* to *Cyrtoceras*, using these words in a somewhat wide sense.

I may here state that I do not count among species of *Cyrtoceras* all the forms attributed to it by de Koninck ('Calc. Carb. Belg.,' 1880); on the contrary, I would exclude all but the following:—*Cyrtoceras* (*Meloceras*) *cornu*, de Kon.; *C.* (*M.*) *acus*, de Kon.; *C.* (*M.*) *Verneuilianum*, de Kon.; *C.* (*M.*) *arachnoideum*, de Kon.; *C.* (*M.*) *Gesneri*, Mart.; *C.* (*M.*) *rugosum*, Flem.; *C.* (*M.*) *rostratum*, de Kon.; *C.* (*M.*) *digitus*, de Kon.; *C.* (*M.*) *imperitum*, de Kon.; *C.* (*M.*) *acus*, de Kon.; *C.* (*M.*) *Nysti*, de Kon.; *C.* (*M.*) *repertum*, de Kon.

The fragment named by de Koninck *Cyrtoceras cornu-bovis* is difficult to allocate, though it seems on the whole to be more akin to *Cyrtoceras* than to any other group. *Cyrtoceras Antilope*, de Kon., another fragment, has only one Cyrtoceran character, viz. a slight curvature, quite insufficient to establish its connection with the genus to which it is referred by de Koninck. It has considerable resemblance to a species described in the first part of this memoir (1897, p. 19) under the name of *Orthoceras hibernicum*, which is also slightly curved. The latter has a more rapidly increasing diameter and somewhat wider septa, and the elements of the siphuncle are not so inflated nor so wide and flattened as they are in the Belgian species. The two species may, nevertheless, fairly be compared, and it was by an oversight that this was not done under the description of the Irish fossil.

Locality.—St. Doulagh's, county of Dublin.

CYRTOCERAS (MELOCERAS) ARCUATOSEPTATUM, sp. nov. Plate XI, figs. 4, 5 *a*, 5 *b*.

Description.—Shell of moderate size, slightly curved in the lower third, but even less so above this; somewhat compressed, probably in part by rock-pressure (this species being from the cleaved rocks of the Cork district). Rate of tapering 1 : 4. Section elliptical, the ratio of the two diameters being as 31 : 25. Of the body-chamber only a small remnant is preserved in one of the specimens before me. Septa (known only by the sutures) numerous; at a diameter of 10 mm. they are 4 mm. apart, at 23 mm. they are 6 mm., and at a diameter of 32 mm. the interval between them has increased to 8 mm., showing that the growth is slow and gradual. In one of the specimens the sutures bend sharply upwards on one aspect of the shell, with a marked obliquity on the sides whence the arches spring. This distinct arching of the septa may partly arise from pressure, but whether this be so or not it is prevalent throughout the specimen. The siphuncle occupies a position farther from the margin than is usual in typical forms of *Cyrtoceras;* the nature of its elements is difficult to determine, owing to the almost total destruction of all internal structures by crystallisation in the specimen cut for the purpose of examining them. The vestige of the siphuncle preserved shows that it was slightly inflated between the septa, and that is all that can be ascertained. The test is quite smooth, and so thin and transparent that the sutures of the septa are plainly seen through it.

Size.—Length of the longest specimen 180 mm.; greatest diameter of the base of the body-chamber 55 mm.; diameter at the (broken) apex 8 mm.

Affinities.—The very slight curvature of this species is its most striking characteristic, and to this may be added the position of the siphuncle. These features militate somewhat against the Cyrtoceran affinities of this fossil, but on the whole I cannot but regard its affinities as being with the genus to which I have referred it; it seems to indicate the presence of a more generalised type than the form described above under the name of *C. apicale,* which, however, it resembles in its limited curvature.

Remarks.—I have been fortunate enough lately to obtain another specimen of this rare and interesting fossil.[1] It is less compressed than the other two examples, and therefore gives a better idea of the normal form of the species; it is imperfect at both ends, and thus can give no further information as to the body-chamber or the apex.

Attention may be drawn to the fact that fig. 4 represents the narrow aspect of the shell, on which the arching of the sutures is clearly seen; while fig. 5 *a*

[1] This specimen is now in the Dublin Museum of Science and Art.

(another example) is drawn from the broader aspect. These figures show the ellipsoidal shape, whether natural or induced, of the species.

Locality.—Little Island, near Cork.

Eusthenoceras,[1] gen. nov.

This genus is founded upon two Irish species described by de Koninck[2] under the names *Cyrtoceras Hulli* and *Cyrtoceras Bailyi*. I shall endeavour to show that these species do not belong to the genus to which they were assigned by de Koninck, but that they are intermediate in their structure between *Orthoceras* and *Cyrtoceras*. From the latter they are excluded by the general straightness of the shell, by the nearly central position and apparently cylindrical form of the siphuncle, as well as by the great depth of the chambers in the proximity of the body-chamber in the adult shell. From the former they differ in the sharp, hook-like curvature of the shell in the young, and in the peculiar arching of the septa on the dorsal (concave) aspect of the shell.

These oscillations between *Orthoceras* and *Cyrtoceras* seemed to justify the separation of this type from both, rather than to sink its individuality in either, and thus to lose sight of it as a connecting link between them. These connecting forms are as rare as they are interesting, hence it is the more necessary that they should be strictly characterised.

In *Eusthenoceras*, as appears from the enumeration of its structural features above given, there is, on the whole, a leaning towards *Orthoceras;* the sutural characters, however, differ as already shown in important points from *Orthoceras* on the one hand, and from *Cyrtoceras* on the other. From the former by their arching on the concave curvature of the shell, from the latter by their great width anteriorly.

A diagnosis of the genus *Eusthenoceras* may be thus constructed:—Shell large, typically curved only in the apical portion; septa at first approximate, afterwards becoming very widely separated; sutures arching upwards on the dorsal or inner curvature of the shell; siphuncle subcentral in the sense of the ventral region, apparently cylindrical. Type, *Cyrtoceras Hulli*, de Koninck.

I have included *Cyrtoceras Bailyi* in this genus, although the single individual representing it departs in some particulars from *Eusthenoceras Hulli*,—that is, the chambers do not become deeper as they approach the body-chamber, the curva-

[1] From εὐσθενής, stout; κέρας, a horn.

[2] 'Annales de la Société Géologique de Belgique,' tom. ix, 1881–2 (Mémoires), pp. 50—60, "Sur quelques Cephalopodes nouveaux du calcaire carbonifère de l'Irlande."

ture of the shell is more regular and persistent than in *E. Hulli*, and the rate of growth more rapid.

If it should be found subsequently by the discovery of other specimens of *Eusthenoceras Bailyi* that the characters found in the isolated individual described persist in others, it may be necessary to modify the description of the genus as given above, or to restrict it entirely to the single species *E. Hulli*, of which there is abundant material.

EUSTHENOCERAS HULLI, *L. G. de Koninck*, sp. Plate XIII; Plate XIV, figs. 1 *a*—*c*, 3.

1882. CYRTOCERAS HULLI, *L. G. de Koninck*. Annales de la Soc. Géologique de Belgique, tom. ix, 1881–2 (Mémoires), pp. 50—60, pl. vi, figs. 1—3.

Description.—Shell elongate, of robust habit, sharply curved in the young, but becoming straight in the adult. Upon a chord of 45 mm. subtending the concave or dorsal side of the apical part of the shell, the greatest curvature is 9 mm. The section is nearly circular in the young shell, but becomes ellipsoidal in the adult, the ratio of the ventro-dorsal to the transverse diameter in an uncompressed specimen (Oldtown) being as 48 : 43. Body-chamber (Pl. XIII, fig. 1 *a*) not quite complete anteriorly, having a length of 150 mm. as compared with 450 mm. for that of the entire shell, exclusive of the apical part, not preserved in the specimen measured, or in the ratio of 1 to 3. Sutures comparatively close-set in the young shell, varying little in the distance separating them until a certain stage of growth is reached, when they suddenly widen, and continue to do so till the body-chamber is reached. In one of the specimens (Pl. XIII, figs. 1 *a*, 1 *b*) the sutures are 10 mm. apart where the greater diameter of the shell is 47 mm., and where this has increased to 65 mm. the sutures are 20 mm. distant from each other. It may be added that in two adjacent chambers, which are respectively the fifth and sixth from the body-chamber, the space between the sutures augments from 16 mm. to 25 mm., the latter width, or very near it, being maintained up to the penultimate chamber, the last chamber being, as usual, somewhat shallower—21 mm. (Pl. XIII, figs. 1 *a*, 1 *b*).

The direction of the sutures varies with the age of the shell; in the young they are nearly horizontal; at a later stage of growth they become distinctly arched (Pl. XIII, fig. 1 *c*) on the dorsal (concave) aspect, passing obliquely over the sides and maintaining the horizontal direction of the young shell on the

ventral (convex) aspect. There are thus three sutural regions—the horizontal, the oblique, and the arched, which probably indicate the form of the aperture. Very fine but distinct ridges or keels, perceptible to sight and touch, traverse the cast longitudinally exactly in the centre of the horizontal and arched sutural regions respectively, and thus diametrically opposite to each other. These ridges are present in all the specimens before me wherever the removal of the test permits of their being seen (Pl. XIII, fig. 1 *c*, drawn a little too broad). Ridges such as these, which are met with on the casts of the shells of Orthoceras, Cyrtoceras, &c., have been called "median" or "normal" lines, but their origin is unknown.

The siphuncle is situated about its own diameter from the centre of the septum, in the region nearest to the ventral border. This agrees fairly well with its position as figured by de Koninck (loc. cit., pl. vi, fig. 3). It is well seen near the apex in de Koninck's type specimen which I have before me, where its position does not differ materially from that which it occupies in the adult shell (Pl. XIII, fig. 1 *e*). In another specimen (Pl. XIV, fig. 3) the siphuncle is almost exactly central; it is seen at the bottom of the deeply concave septum partly indicated in the figure. Some obscure remains of the siphuncle (near the upper part of the figure) seem to show that it was cylindrical, but this may be deceptive; its nearly central position at least is quite clear.

The test, which was apparently thick, is perfectly smooth; it is well preserved upon all the specimens before me.

Size.—The largest uncompressed specimen, that from Oldtown (Pl. XIII), has a total length, excluding the apex which is broken off, of about 450 mm.; its greatest diameter, measured about the middle of the body-chamber, is 73 mm.; the apical end (imperfect) measures about 18 mm. in diameter.[1]

The total length of the specimen (without body-chamber) figured by de Koninck (loc. cit., pl. vi, fig. 1) is 260 mm.; the greatest diameter 70 mm., the least (not far from the apex) 12 mm.

The other specimen figured by de Koninck (pl. vi, fig. 2), though wanting the body-chamber, has indications in the great depth of the last four or five chambers that the latter is nearly reached, though the base of it is not seen. Probably de Koninck's estimate of the total length of this specimen (500 mm.) is not very wide of the mark.

Affinities.—The only species known to me which can be compared with the present one is *Eusthenoceras Bailyi*, de Kon., sp., about to be described. Only a single specimen of it was found, but it happens to be tolerably complete, and therefore admits of a comparison with *E. Hulli*. It consists of the greater part

[1] Though designed to show the arching of the septa and the median line, fig. 1 *c* also illustrates the larger diameter of the fossil as contrasted with the smaller, which is seen in fig. 1 *a*.

of the septate division of the shell with the body-chamber attached. The latter is not quite perfect, but a fair approximation of its form and size may be arrived at. The septa exhibit the closeness of arrangement characteristic of *E. Hulli* in a similar stage of growth, and there is the same arching upwards in them upon the dorsal or inner curvature of the shell (cf. Pl. XIII, fig. 1 *b*—lower portion, from the part marked *a*, *b*).

The differences between the two species may be summed up as follows :—the body-chamber is larger in proportion to the entire shell in *E. Bailyi* than it is in *E. Hulli*. The septa in the former do not increase greatly in their distance apart towards the body-chamber, the reverse of this being the case in the latter species. The section is nearly circular throughout the shell in *E. Bailyi;* it becomes markedly elliptical in the adult in *E. Hulli*. Lastly, the curvature is more regular and continuous in *E. Bailyi* than in *E. Hulli*, in which it becomes nearly straight at about the lower third of the shell.

Remarks.—The great size of the individuals belonging to this species is worthy of note, and did not escape de Koninck's attention in his description of the species. There were giants in those days in the Carboniferous seas of the British and Belgian areas; this may at least be said of the Cephalopoda, for not only did *Actinoceras giganteum* flourish and abound, but there were also gigantic forms of many of the coiled shells, such as *Cœlonautilus carinifer*us, *Asymptoceras dorsale*, and others. Favourable environment, immunity from the attacks of their enemies, and other physical conditions may be invoked to account for such unusual development, which was most marked in the Irish area.

Returning to the subject of these remarks, it cannot but be conceded, I think, that the group to which I have given the name *Eusthenoceras* is transitional in character between *Orthoceras* and *Cyrtoceras;* the persistence of the characters noted in *Eusthenoceras* in several individuals being of such a nature as to allay any suspicion of their representing merely individual variations or abnormalities of some kind. If this be the true interpretation of the phenomena presented by these fossils, it is a further proof that the specialisation characteristic of the race of the Cyrtoceratidæ met with in the Silurian and Devonian rocks was not maintained in the Carboniferous period, but that, contrariwise, a series of forms then appeared in which a more simple structure was the leading feature. These witnessed the dying out of the race, which did not survive the close of the Carboniferous period.

I am again indebted to Prof. Joly, who lent me the fine specimen figured on Pl. XIII, which gives valuable information regarding the structure of the present species not furnished by the other examples.

Localities.—Oldtown, Queen's County; Rathkeale, county of Limerick.

EUSTHENOCERAS BAILYI, *L. G. de Koninck*, sp. Plate XIV, figs. 2 *a*, 2 *b*.

1882. CYRTOCERAS BAILYI, *L. G. de Koninck*. Annales de la Soc. Géologique de Belgique, tom. ix, 1881–2 (Mémoires), pp. 50—60, pl. v, fig. 1.

Description.—Shell (the only example known) of moderate size, strongly curved in the apical part, but becoming straighter as the body-chamber is approached. Upon a chord of 97 mm. subtending the concave side the greatest curvature is 17 mm. The section is circular in the young stage of growth, and does not deviate from this form in the adult. The body-chamber is of considerable length. As to its length in proportion to that of the entire shell only an approximation can be come to, for part of the apex is wanting, and the body-chamber itself is not perfect, but it would appear to have been nearly one-half.

The septa are approximate and deeply concave. At a diameter of 25 mm. they are 6 mm. apart; where the diameter has increased to 38 mm. they are 10 mm. distant, there being an interval of about 40 mm. between the two points measured. It can thus be seen that the septa increase very gradually in their distance from each other.

The sutures arch slightly forwards on the dorsal or inner curvature of the shell, and become straight on the ventral aspect, a condition the reverse of what is generally encountered in these curved shells (cf. Barrande, 'Syst. Sil. de la Bohême,' vol. ii, pl. cli, figs. 28—30).

The siphuncle as seen in the concavity of the last formed septum is about twice its own diameter above the centre, that is towards the ventral or convex side of the shell (Pl. XIV, fig. 2 *b*).

The test is quite smooth.

Size.—Length, measured along the outer curvature, 225 mm., of which the body-chamber occupies about 100 mm.; greatest diameter, measured near the centre of the body-chamber, 56 mm., least 12 mm., the latter not far from the apex.

Affinities.—I was at first inclined to the opinion that the present species was the young of *Eusthenoceras Hulli*, and my doubts upon this point are not entirely dispelled. One of the most marked features in *E. Hulli* is the extraordinary size of the chambers in the adult stage of growth. Should *E. Bailyi* prove to be the young of *E. Hulli* this abnormal development of the chambers could not have been attained. On the other hand, the curvature of the shell in the present species is much less restricted than it is in *E. Hulli*, giving a very different aspect to the shell. Single specimens are always difficult to deal with unless they have some very distinctive features, and it must be left to individual opinion to

determine in these cases whether such features are of sufficient importance to entitle their possessor to be treated as an independent species, or, on the other hand, whether it should be merged in one already established. Any future attempt to determine with more certainty the affinities of *E. Bailyi* must depend upon fresh evidence; as the matter at present stands it is preferable to retain de Koninck's name for this fossil.

Locality.—Samphire Island, county of Kerry.

Family POTERIOCERATIDÆ.

Genus POTERIOCERAS, *M'Coy*, 1844.

POTERIOCERAS FUSIFORME, *J. de C. Sowerby*, sp. Plate XV.

1829. ORTHOCERA FUSIFORMIS, *J. de C. Sowerby*. Min. Conch., vol. vi, p. 167, pl. dlxxxviii, fig. 1 (excl. fig. 2).
1836. ORTHOCERAS FUSIFORME, *Phillips*. Geol. of Yorkshire, pt. 2, p. 238, pl. xxi, figs. 14, 15.
1844. POTERIOCERAS FUSIFORME, *M'Coy*. Synop. Carb. Foss. Ireland, p. 10.
1844. APIOCERAS FUSIFORME, *Fahrenkohl*. Bull. Soc. Imp. Nat. Moscou, vol. xvii, p. 781.
1854. ORTHOCERAS FUSIFORME, *Haughton*. Journ. Geol. Soc. Dublin, vol. vi, p. 48, pl. —, fig. 4.
1855. — (POTERIOCERAS) FUSIFORME, *M'Coy*. Brit. Pal. Foss., fasc. iii, p. 569.
1862. POTERIOCERAS FUSIFORME, *Griffith*. Journ. Geol. Soc. Dublin, vol. ix, p. 55.
1876. — — *Armstrong, Young, and Robertson*. Catalogue of the Western Scottish Fossils, p. 59.
? 1880. GOMPHOCERAS FUSIFORME, *L. G. de Koninck*. Faune Calc. Carb. Belg., tom. v, p. 42, pl. xxxvii, figs. 4 *a*—*c*.
1888. POTERIOCERAS FUSIFORME, *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 1, p. 259.

Description.—Shell of medium size, fusiform, gradually expanding, and then contracting towards the aperture, curved in the apical region, straight above; flattened on the ventral or outer curvature, conspicuously inflated on the dorsal side (Pl. XV, fig. 1 *c*). The apical part slender and tapering to a fine point. Upper part of body-chamber contracted in the region of the aperture, which is simple as in *Cyrtoceras*. Septa and base of body-chamber markedly oblique at the sides, the septa nearly horizontal in the siphuncular region, strongly arching upwards along the median line of the dorsal region (Pl. XV, figs. 1 *a*, 1 *c*). Septa

fairly approximate, about 5 mm. distant from each other in the vicinity of the body-chamber. Siphuncle near the margin of the ventral, flattened side; strongly inflated between the septa. Test perfectly smooth.

Size.—Length of the most perfect specimen (wanting anterior portion of body-chamber) 160 mm., length of septate part 120 mm., length of portion of body-chamber preserved 50 mm.

Affinities.—The plano-convex form of the shell and the more numerous septa are features that readily distinguish this species from the one next to be described, viz. *Poterioceras latiseptatum*, Foord; its much more slender proportions separate it unequivocally from *Poterioceras cordiforme*, J. Sowerby.

Remarks.—A specimen of this species having been obtained with the apex nearly perfect, a much better conception of the shape of the shell can now be formed than has been possible hitherto. The extreme apical point is unfortunately broken in the specimens available, so that nothing can be ascertained with reference to the presence of a cicatrix or other embryological mark.

Through the kindness of my friend Mr. G. C. Crick, of the Geological Department of the British Museum, I have been enabled to reproduce a drawing he made for me of the posterior end of Sowerby's type specimen of the present species contained in that museum. The principal dimensions of Sowerby's specimen are as follows: total length 162 mm., length of body-chamber 65 mm., length of septate part 97 mm., diameter of base of body-chamber 56 mm. (nearly). It is, of course, not possible to make a very close comparison between the type specimen and the one whose dimensions are given in the above description of the species (see Pl. XV, figs. 2 *a*, 2 *b*), as they are both imperfect, the one anteriorly, the other posteriorly; but, judging by the two measurements, there is probably not much difference between them, the proportions being the more easily realised as the specimens are nearly the same size.

There is a noteworthy agreement in the figures of this species given by different authors in respect to the remarkably plano-convex form of the shell when the ventro-dorsal profile is looked at (Pl. XV, fig. 1 *c*). This shape may not always be equally strongly pronounced, but it asserts itself distinctly enough in most of the figures I have seen, hence it furnishes a good guide for the identification of the species (cf. Phillips, 'Geol. Yorks.,' loc. cit.; Haughton, 'Journ. Geol. Soc. Dublin,' loc. cit.).

De Koninck's figure of this species, which he called unaccountably "*Gomphoceras* fusiforme," represents a longer and more slender form than Sowerby's; it is a question, therefore, in what category it should be placed. It appears to me to be distinct from *P. fusiforme*. In the description de Koninck states that the ventral side is more convex than the dorsal, so that in this point at least there is agreement between the two forms. *P. fusiforme* is nevertheless clearly a much

shorter and more inflated form than that to which de Koninck has given the same *specific* name.

De Koninck's allocation of *P. fusiforme* to *Gomphoceras* was unfortunate considering that not only is the aperture simple in *Poteriocerus*, but the form of the shell is different from the latter, even allowing for the absence of the apical part in *Gomphoceras*, which gives to this form a stumpy and, if I may so express it, ungraceful outline. The complicated, multilobate aperture of *Gomphoceras* indicates structures in at least the oral parts of the animal which would certainly be regarded as of generic importance in any living form, and it is therefore with no great latitude that we assign a distinct generic position to the fossil.

Localities.—St. Doulagh's, county of Dublin; Millicent (Clane), county of Kildare (M'Coy, Haughton); Kildare, (exact locality not stated) (Phillips); Little Island, near Cork (Dublin Museum of Science and Art).

POTERIOCERAS LATISEPTATUM, sp. nov. Plate XVI.

Description.—Shell of moderate size, fusiform, slender, inflated, the inflation being most prominent dorso-ventrally, and, influenced by the curvature of the shell, a little higher on the ventral than on the dorsal aspect (Pl. XVI, fig. 2 *a*). Section nearly circular when uncompressed. The shell tapers gradually from the very acute apex, the inflation beginning at about the mid-length, becoming contracted in diameter towards the aperture. The apex has a central, very shallow pit, surrounded by a thickened rim; in the centre of the pit there is a circular spot representing the orifice of the siphuncle through which the latter passed out of the protoconch or embryonic chamber. The diameter of the apex is 2 mm. (Pl. XVI, fig. 2 *a*). The body-chamber (partly exposed in some of the specimens by the removal of the test) has an undulating outline at the base, but in a general sense it is horizontal.

The septa are comparatively distant, there being seven in a length of 45 mm. in this species, against ten in *P. fusiforme* in the same length. The last two or three chambers are very shallow in some specimens (Pl. XVI, fig. 4). The course of the sutures is slightly oblique on the lateral areas of the shell (Pl. XVI, fig. 3 *a*).

The siphuncle is situated near the convex margin; fig. 4 shows its position, which is seen to become gradually more nearly central as the shell grows. It has, unfortunately, not been cut quite through the centre in the specimen figured, consequently the segments do not appear to completely fill up the space they occupy between the septa, and owing to this also they have an oval instead of a nearly circular form.

The test is quite smooth.

Affinities.—This species is nearly related to *Poterioceras fusiforme*, J. Sow., sp., from which it is readily distinguished by its wider and less oblique septa, and by its being almost equally inflated on the ventral and dorsal areas.

Remarks.—None of the specimens of this well-marked species have been up to the present time obtained at St. Doulagh's, and it is remarkable that many of the species obtained there differ from those yielded by the Clane quarries, less than twenty-five miles distant. This is especially the case with the Cephalopoda.

Localities.—Clane, county of Kildare; county of Limerick (exact locality unknown).

Poterioceras ventricosum, *M'Coy*. Plate XVII.

? 1843. Orthoceras latissimum, *J. E. Portlock*. Rep. on the Geol. of Londonderry, p. 390, pl. xxxv, figs. 2 *a*, *b*.

1844. Poterioceras ventricosum, *M'Coy*. Synop. Carb. Foss. Ireland, p. 10, pl. i, fig. 2.

1888. — cordiforme (pars), *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 1, p. 260.

Description.—Shell large, broadly fusiform, much inflated in the upper half, curved in the apical part, the most inflated part being ventro-dorsal as in *P. fusiforme*. The body-chamber, which comprises the most inflated part of the shell, contracts towards the aperture; the base is markedly oblique, conforming in this respect to the chambers which precede it. The chambers, as indicated by the suture-lines, are very shallow, the distance between them not exceeding 8 mm. where the diameter of the shell varies from 50 mm. to 70 mm. (Pl. XVII, fig. 2 *a*), thus showing a remarkable uniformity of spacing. The same uniformity is found in another somewhat larger specimen, so that it may be taken as a characteristic feature of this species. The section in the young shell is slightly elliptical, the ratio of the two diameters being as 30 : 27. The siphuncle in the young shell is situated at about one-third of the distance across the longer diameter (Pl. XVII, fig. 2 *b*); M'Coy describes it as "large, inflated, and slightly excentric," which probably refers to its position in the adult; if so, it gradually assumes a nearly central position as in some other cephalopod genera.

The surface of the test is beautifully ornamented with a series of faint longitudinal ridges, easily seen when the light falls upon them from the side; they may also be felt (Pl. XVII, fig. 1 *a*). These ridges or bands are crossed by very numerous delicate lines of growth, with stronger ones at intervals.

Size.—Length of the most perfect of the specimens figured (fig. 2 *a*; wanting the apical part), 170 mm.; greatest diameter 110 mm.; least 30 mm. A larger specimen (a cast) collected by myself and now in the Museum of Science and Art, Dublin, has the following dimensions: length 210 mm.; greatest diameter (body-chamber) 120 mm.; least about 20 mm. This specimen is imperfect at both ends, though considerably more than half of the body-chamber remains, as is indicated by its contraction above the inflated part showing proximity to the aperture.

Affinities.—The species most nearly related to the present one is undoubtedly *P. cordiforme*, J. Sow., a very large species found in the Red Sandstone Group of the Calciferous Sandstone, at Closeburn, Dumfriesshire. I have, in fact, in the 'Catalogue of Fossil Cephalopoda, British Museum,' 1888, Part 1, p. 260, made M'Coy's species a synonym of Sowerby's, being at that time unable to find adequate grounds for their separation. With better material at my disposal I now deem it advisable to keep them apart, because, in addition to the ornamentation described above, there is a slight but distinct curvature in *P. ventricosum* in the young shell; this may be seen in both the specimens I have figured. This may be better realised by extending the outline of the apical end of the figures until the lines thus drawn meet together; a very perceptible curvature is the result.

Remarks.—Though only a small fragment, consisting of about six chambers, Portlock's species, *Orthoceras latissimum*, is difficult to distinguish from M'Coy's: the septa are equally distant in the two forms, and the position of the siphuncle, a minor consideration here, is apparently also the same. Portlock's specimen, which is labelled "Kildare" (meaning probably Clane, which is in the county of Kildare), is still to be seen in the Museum of Science and Art, Dublin, having survived the vicissitudes through which the "types" figured by Portlock and M'Coy have passed before reaching their present resting-place.

It is to be regretted that M'Coy should not have referred in his description of *P. ventricosum* either to Portlock's or even to Sowerby's species.

Locality.—Clane, county of Kildare.

The genus *Poterioceras*, with which the uncoiled forms of Cephalopod shells terminate in this memoir, has a wide stratigraphical range, extending from the Ordovician to the Carboniferous. Though the first species described was a Carboniferous one ("*Orthocera*" *cordiformis*, J. Sowerby, 'Min. Conch.,' vol. iii, 1821), the genus originated, as stated above, in rocks of Ordovician age. Under the

generic name *Oncoceras*,[1] James Hall described several species from the Ordovician and Silurian rocks of the State of New York. The genus was afterwards recognised by Billings (who employed Hall's generic name) from rocks of the Niagara group in Canada, and a number of species of it were described by him ('Catalogue of the Silurian Fossils of Anticosti,' 1866). M'Coy, in his 'Synopsis of the Silurian Fossils of Ireland,' 1846, described and figured *Poterioceras approximatum* from Ordovician rocks, but this appears to have been a somewhat doubtful determination as regards the genus.[2]

Of Silurian species of *Poterioceras*, Barrande described some from his Étage E, among which may be mentioned *P. heteroclitum* ('Syst. Sil. Boh.,' vol. ii, pl. cxviii) and *P. lumbosum* (ibid., pl. ccccl xiv).

The Devonian rocks have yielded a few species, among which may be cited *Orthoceratites subfusiformis*, Münster,[3] *O. subpyriformis*, Münster, and *Gomphoceras sulcatulum*, Murch. de Vern., and de Keyserl.[4] To these may be added the species described by Whidborne in his valuable "Monograph of the Devonian Fauna of the South of England" (Palæont. Soc. vol. for 1889), under the names *Poterioceras vasiforme*, *P. Marri*, and *P. ellipsoideum*.

In the Carboniferous rocks only four species are known to me with certainty as referable to *Poterioceras*: these are *P. cordiforme*, J. Sowerby; *P. fusiforme*, J. de C. Sowerby; *P. ventricosum*, F. M'Coy; *P. latiseptatum*, A. H. Foord. Probably de Koninck's species, *Gomphoceras fusiforme* (not Sowerby's) and *G. lagenale* also belong here.[5]

Poterioceras is nowhere very rich in species, the most numerous in any rocks being those of the Ordovician and Silurian of North America.

[1] M'Coy's name *Poterioceras* has priority over this one, which was adopted by Hall for what he no doubt considered at the time he wrote to be a distinct genus ('Palæont. New York,' vol. i, 1847).

[2] See Blake, 'British Foss. Ceph.,' 1882, pt. 1, pl. xxiv.

[3] 'Beiträge zur Petrefactenkunde,' 1840.

[4] 'Géol. de la Russie d'Europe,' vol. ii, Palæont.

[5] 'Faune Calc. Carb. Belg.,' tom. v, 1880.

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MONOGRAPH

ON THE

CARBONIFEROUS CEPHALOPODA

OF

IRELAND.

BY

ARTHUR H. FOORD, Ph.D. (Münch.), F.G.S.

PART III.

CONTAINING THE FAMILIES

TAINOCERATIDÆ, TRIGONOCERATIDÆ, TRIBOLOCERATIDÆ, RINECERATIDÆ, COLOCERATIDÆ, AND SOLENOCHEILIDÆ (in Part).

Pages 49—126: Plates XVIII—XXXII.

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Family TAINOCERATIDÆ.

Genus TEMNOCHEILUS, *M'Coy*, 1844.

TEMNOCHEILUS CORONATUS, *F. M'Coy*. Plate XVIII, figs. 1 *a*, *b*, 2 *a*, *b*.

1844. NAUTILUS (TEMNOCHEILUS) CORONATUS, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 20, pl. iv, fig. 15.

1860. TEMNOCHEILUS CORONATUS, *R. Griffith*. Journ. Geol. Soc. Dublin, vol. ix, p. 56.

1878. NAUTILUS CORONATUS, *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, Palæont., tom. ii), pt. 1, p. 115, pl. xxiv, fig. 2.

1894. TEMNOCHEILUS CORONATUS, *A. H. Foord and G. C. Crick*. Geol. Mag., dec. 4, vol. i, p. 295 (woodcut).

Description.—Shell thick-discoid, subglobose, the inner whorls exposed in a wide and deep, crateriform umbilical cavity. The whorls are about three in number, with a central vacuity of moderate size and elliptical shape. The section is trapezoidal in form, the ventral area being much wider than the dorsal, which it overhangs considerably. The ratio of the vertical to the transverse diameter of the whorls may be reckoned at about 22 : 47. The periphery is gently rounded, the margins being marked by the characteristic tubercles. The umbilical walls are very steep, their sides slightly inflated in the lower half. The enrolment completely covers the ventral area up to the row of tubercles, which are thus visible on the inner whorls from their first development.

The septa (not well seen in any of the specimens that have come before me) are about 10 mm. apart on the ventral area, where the diameter of the shell is 90 mm.; they are, therefore, very numerous. The siphuncle appears to be a little above the centre, judging by its position in the type specimen, which is much distorted.

The ornaments consist of a row of tubercles situated at the angle formed by the junction of the peripheral area with the umbilical wall. Beginning at about the mid-length of the first whorl as obscure undulations, the tubercles gradually increase with the growth of the shell, until at about the second whorl they have become relatively large and prominent. They are of a flattened conoidal form, slightly elongated longitudinally. There are fourteen tubercles to a whorl in an adult shell. A faint raised line encircles the walls of the umbilicus on the inner whorls just beneath the row of tubercles. The periphery is quite smooth.

The young shell is beautifully marked with numerous longitudinal thread-like lines, which, being crossed by the equally regular and numerous lines of growth,

produce a cancellated pattern of ornament comparable with that of the recent *Nautilus* in the same stage of growth, and of other coiled extinct Nautiloid shells (*Discitoceras*, *e. g.*) which lose this ornamentation in the adult shell. The transverse lines become obsolete before the end of the first whorl, but the longitudinal lines die out at about the first quarter of the second whorl, among the last to disappear being two lines just below the tubercles. Transverse lines of growth of a sigmoid form (much drawn out) are seen when the test is well preserved.

Affinities.—M'Coy ('British Palæozoic Fossils,' p. 588) remarks that the present species is distinguished completely from *N. tuberculatus*[1] by the great thickness or width of the mouth as compared with the diameter, the much more rapidly enlarging whorls, much deeper and narrower umbilicus, direction of the flattening of the tubercles, acutely elliptical form of the transverse section of the whorls, and forward instead of backward wave of the edge of the septa at the middle of the periphery. The accuracy of this summary of the divergent characters of the present species when compared with *Temn. tuberculatus* is established by an examination of the type specimen of the latter in the British Museum.

De Koninck, in describing the present species from Visé, Belgium, compares it with *N. biangulatus*, J. de C. Sowerby (*? Cœlonautilus cariniferus*, J. de C. Sowerby, sp.), and with *Nautilus tuberculatus*, J. Sowerby, and *Nautilus latus*, Meek and Worthen. He distinguishes M'Coy's species from Sowerby's and Meek and Worthen's by its smaller size, the greater relative height of its aperture, the depth of its umbilicus, and the form of the septa. As far as can be judged by the figures, there seems much to justify de Koninck's identification of the Visé fossil with *Temnocheilus coronatus;* and Mr. E. J. Garwood expressed the same view, in a letter to the writer, after having seen the specimens in the Natural History Museum at Brussels in 1893.

Remarks.—Until Mr. E. J. Garwood's fortunate discovery of this species in the Carboniferous Limestone of Stebden Hill, near Cracoe, Yorkshire,[2] it was but imperfectly known. The fine series he collected has added all the necessary information, though M'Coy, it is true, was enabled to somewhat amend his original description of the species by means of specimens afterwards obtained in the Carboniferous Limestone of Lowick, Northumberland.[3] One of Mr. Garwood's specimens, now in the British Museum, is figured for comparison with M'Coy's type, and to show the characters of the young shell, which are not seen in the latter (Pl. XVIII, figs. 1 *a*, 2 *a*).

[1] J. Sowerby, 'Min. Conch.,' vol. iii, p. 90, pl. ccxlix, fig. 4.

[2] 'Geol. Mag.,' dec. 4, vol. i, p. 295.

[3] These are in the Woodwardian Museum, Cambridge.

Only one specimen has been, up to the present time, found in Ireland, viz. M'Coy's type, figured in the "Synopsis" (*loc. cit.*). This was formerly in the collection of the late Dr. Haines of Cork. M'Coy's figure of it is "restored," unless it has suffered damage since it was introduced into his work.

Locality.—Little Island, near Cork.

Family TRIGONOCERATIDÆ.

Genus TRIGONOCERAS, *M'Coy*, 1844.

TRIGONOCERAS PARADOXICUM, *J. de C. Sowerby*, sp. Plate XVIII, figs. 3 *a*, *b*, *c*, 4 *a*, *b*, 5.

1825. ORTHOCERA PARADOXICA, *J. de C. Sowerby*. Min. Conch., vol. v, p. 81, pl. ccccl vii.

1836. ORTHOCERAS PARADOXICUM, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 239.

1844. — (TRIGONOCERAS) PARADOXICUM, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 9.

1855. — — — *F. M'Coy*. British Palæozoic Fossils, fasc. 3, p. 573.

1880. GYROCERAS PARADOXICUM, *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, tom. v), pt. 2, p. 7, pl. xxxii, figs. 3, 3 *a*, 3 *b*.

1883. TRIGONOCERAS PARADOXICUM, *A. Hyatt*. Proceed. Boston Soc. Nat. Hist., vol. xxii, 1882—3 (1884), p. 291.

1891. GYROCERAS (TRIGONOCERAS) PARADOXICUM, *A. H. Foord*. Cat. Foss. Ceph. Brit. Mus., pt. 2, p. 70, fig. 7.

1893. TRIGONOCERAS PARADOXICUM, *A. Hyatt*. Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 404.

Description.—Shell rapidly tapering, "abruptly incurved towards the smaller end, forming half a volution" (M'Coy), the rest of the shell gently curved. In a given specimen it was found that upon a cord of 130 mm., subtending the concave side of the shell, the greatest curvature was 20 mm. The section is distinctly shield-shaped, the ventral area slightly concave, the sides, at first nearly straight, are curved below, converging towards the median line, where there is a ridge or keel which is not very prominent. Two strong keels on each side of the peripheral area run parallel to the marginal one (Pl. XVIII, fig. 4 *b*). The

margins of the peripheral area are produced into a prominent rounded ridge, outside of which and near to it there is a conspicuous keel extending the whole length of the shell. In the young shell there are about ten similar keels, five on each side, in the space between the ridge bounding the peripheral area and the dorsal keel. In well-preserved young specimens these lines may be so strong as to give a fluted appearance to the shell, but in the adult they become gradually obsolete. The shield-shaped form of the section may originate in the earliest stages of growth; it is, at any rate, fully developed in a young specimen to which I have had access, in which the diameter of the broken apical extremity is 6·5 mm. In addition to the ornaments above described, the whole of the peripheral area is covered with exceedingly fine, close-set, longitudinal lines, which persist in all stages of growth, becoming relatively coarser in the adult shell; they are not present on the sides of the shell. Fine transverse lines of growth pass in a sigmoid curve across the sides of the shell, continuing their course over the dorsal keel, and forming upon the peripheral area a well-marked, backwardly directed, hyponomic sinus, very conspicuous upon the body-chamber of old shells.

The septa are numerous; in the young shell they are 3 mm. apart upon the ventral area where its diameter is 18 mm. In a very large specimen, the dimensions of which are given below, the septa are 8 mm. apart, where the diameter of the shell measured upon its sides, from the keel bounding the peripheral margin to the one in the median line of the dorsal area, is 45 mm. The chambers are thus shallow. The necks of the septa are short and but slightly curved backwards.

The siphuncle is cylindrical, and is nearly 3 mm. in diameter where the lateral diameter of the shell is 22 mm.; thus it is about one-seventh the ventro-dorsal diameter of the shell.

Size.—The largest specimen known to me (a fragment contained in the "Grainger Collection" in the Free Public Library and Museum, Belfast) consists of the greater part of the body-chamber and one air-chamber. Its dimensions are as follows:—Greatest length, measured along the outer curvature, 195 mm.; dorso-ventral diameter of the smaller extremity 37 mm., of the larger 70 mm.

Remarks.—At present only two species of *Trigonoceras* have been recognised, viz. *T. paradoxicum*, J. de C. Sowerby, and *T. aigoceras*, G. zu Münster,[1] but there appears to be some reason for believing that there is a third species. Professor Hyatt remarks ('Geological Survey of Texas, Fourth Annual Report,' 1892, p. 405) that Sowerby's species is quite distinct from the Belgian one, the latter being apparently without any longitudinal ridges; the unique specimen described and figured by de Koninck[2] is, however, a cast, and would hence fail to show any

[1] *Cyrtocera aigokeros*, 'Beiträge zur Petrefactenkunde' (1st edit.), 1838, Heft 1, p. 33; 2nd edit., 1843, Heft 1, p. 56, Taf. 1, figs. 7 *a*, *b*; Taf. 2, fig. 1.

[2] 'Calc. Carb.,' pt. 2, p. 7, pl. xxxii, figs. 3, 3 *a*, 3 *b*.

ridges, or would show them so faintly as to cause them perhaps to be overlooked. A specimen from St. Doulagh's, which came under my notice (it is not now accessible to me), may prove to be a distinct species; it is more rapidly tapering and more slender, and has a stronger curvature than *T. paradoxicum*. On comparing the curvature of the two species (assuming for the moment that they are distinct) it is found that in the St. Doulagh's shell the greatest curvature upon a chord of 70 mm. subtending the concave side is 25 mm.; while in a specimen of *T. paradoxicum* from Clane, now before me (Pl. XVIII, figs. 3 *a*, *b*), the greatest curvature, upon a chord of 70 mm. subtending the concave side, is 6 mm., or about one-fourth the above amount—a very considerable discrepancy.

A fragment from Clane in the Grainger Collection shows narrow bands of colour of a dark brown hue and of a zigzag pattern, curving a little as they approach the dorsal keel (Pl. XVIII, fig. 5).

It is unfortunate that the specimen mentioned by M'Coy as exhibiting the incurved apical extremity was contained in a private collection, that of the Rev. Dr. Sirr. The prospect of tracing this collection is now, after such a long lapse of years, hopeless, and we must trust to renewed search for the completion of our information regarding the structure of *Trigonoceras*. My friend Mr. Joseph Wright, F.G.S., of Belfast, informs me that he saw, many years ago, two specimens of *Trigonoceras* in the Museum of Science and Art, Dublin, each with the apex preserved, as described by M'Coy. These also have long since disappeared. It is satisfactory, however, to have M'Coy's observation confirmed by so competent an observer.

Localities.—Clane, county of Kildare; Rathkeale and Doohyle (near Rathkeale), county of Limerick; St. Doulagh's, county of Dublin.

Genus Cœlonautilus, *Foord*, 1891 (emend. *Hyatt*, 1893).

Group of Cœlonautilus planotergatus.

a. Cœlonautilus planotergatus, *F. M'Coy*, sp. Plate XIX, figs. 1 *a*, *b*, 2 *a*—*c*.

1844. Nautilus (Discites) planotergatus, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 18, pl. ii, fig. 2.

1860. Discites planotergatus, *R. Griffith*. Journ. Geol. Soc. Dublin, vol. ix, p. 56.

1878. Nautilus planotergatus, *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, tom. ii), pt. 1, p. 117, pl. xxvi, figs. 1—3.

1891. Discites planotergatus, *A. H. Foord.* Cat. Foss. Ceph. British Museum, pt. 2, p. 93.

1893. Cœlonautilus planotergatus, *A. Hyatt.* Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 407.

Description.—Shell very thick-discoid, with subquadrate whorls, a deep umbilicus with step-like declivities from one whorl to the other, and a small central vacuity. The section of the whorls is hexagonal, and slightly concave along the median line of the peripheral area; the zone of impression is rather shallow. The body-chamber is rather large, and occupies nearly half of the last whorl. The rate of increase in the whorls is slow, and their width is about equal to that of the periphery. The umbilicus is wide and deep, and its step-like character very conspicuous. The sides are angular, both at the edge of the peripheral area and at that of the umbilicus, but there are no keels. In aged individuals the angularity of the umbilical margin is greatly lessened on the body-chamber in the vicinity of the aperture (Pl. XIX, fig. 1 *a*). The character of the aperture can only be inferred from the sinuous lines on the peripheral area, which show it to have had a moderately deep hyponomic sinus. The inner whorls exhibit the same quadrate character as the outer ones, which they resemble in miniature. Two obscure longitudinal elevations are present on the peripheral area of the young shell, which leave a very shallow median depression and a slight depression between them and the edge of the area. As the shell advances in growth, fine longitudinal thread-like lines or ridges are developed upon the peripheral area on each side of the shallow median depression, and in the proximity of the margin. These appear to become obsolete in the adult shell, as far as the material at my disposal enables me to judge. The surface of the test is covered with fine striæ of growth. These are well figured by de Koninck ('Calc. Carb.,' pt. 1, pl. xxvi, figs. 2, 3 *a*, 3 *c*).

The septa are fairly approximate. In the young shell, where the width of the peripheral area is 13 mm., they are 4 mm. apart in the median line; at a width of 17 mm. this distance has increased to 7 mm., and in the adult shell, at a width of 24 mm., they are 8 mm. apart, and in a large individual they are 12 mm. apart where the side measures 40 mm. across. The sutures are curved deeply backwards on the sides of the shell, and form sharply bent-back lobes upon the peripheral area. The sutural characters in this species are thus clearly marked, and are important aids in its identification (Pl. XIX, figs. 1 *b*, 2 *a*, 2 *b*).

The siphuncle, as seen in a natural section of a septum, is situated in the upper third, that is considerably above the centre (Pl. XIX, fig. 2 *c*).

Dimensions.—M'Coy affirms that this species often attains a diameter of 10

inches (254 mm.). The largest I have seen (Museum of Science and Art, Dublin) measures 160 mm. in its greatest diameter, the diameter of the umbilicus measured from the opposite margins being 75 mm. The central vacuity in another specimen measures 14 mm., thus far exceeding in the latter dimension de Koninck's figured specimens. The periphery is 45 mm. in width, the sides about 50 mm. in the widest part available for measurement.

Affinities.—*C. gradus*, though resembling the present species in the markedly quadrate form of its whorls, is easily distinguished therefrom by its much slower rate of increase, the much greater width of the peripheral area compared with the sides, and by its large central vacuity. Moreover it does not appear to attain the large size to which *C. planotergatus* develops.

Remarks.—Unfortunately the specimens available for my present study of the species, which includes M'Coy's type, are distorted by rock pressure; moreover they do not exhibit the complete growth of the shell through all its stages, hence my description is to some extent imperfect.

On the whole, de Koninck's figures of *C. planotergatus* give me the impression of a shell with less distinctly quadrate whorls and a much shallower umbilicus than the forms which have come under my notice.

This species was originally named *Nautilus hexagonus* by de Koninck,[1] but, as the name had already been used by J. Sowerby for a Jurassic species, it had to be discarded, and the specific name *planotergatus*, given by M'Coy[2] to what appeared to be the same form, was accepted by de Koninck[3] and subsequent writers. Prof. Hyatt,[4] however, on comparing specimens of the Belgian species (*Nautilus hexagonus*, L. G. de Koninck) contained in the Museum of Comparative Zoology, Cambridge, Mass., with M'Coy's species, comes to the conclusion that they are distinct. He remarks that the Belgian species "has a whorl in the young with more convergent[5] sides [than those of *C. planotergatus*], and is not so broad proportionately on the abdomen [periphery], and has therefore the gerontic [senile] form at an earlier stage." He thinks, therefore, that it is better to retain the name of *C. hexagonus;* on his authority I have accordingly omitted it from the list of synonymy of *C. planotergatus*.

Localities.—Cork (near the city); Rathkeale, county of Limerick.

[1] 'Descrip. Anim. Foss. Terr. Carb. Belgique,' 1844, pl. xxv, fig. 1.

[2] 'Synop. Carb. Foss. Ireland,' 1844, p. 18, pl. ii, fig. 2.

[3] "Faune Calc. Carb. Belgique" ('Ann. Mus. Roy. d'Hist. Nat. Belgique,' Paléont., tom. ii), pt. 1, p. 117, pl. xxvi, figs. 1—3.

[4] "Carboniferous Cephalopods." Second paper. 'Geological Survey of Texas, Fourth Annual Report,' 1892, p. 408.

[5] This term signifies that the sides of the whorl are inclined outwardly or towards the periphery, instead of towards the umbilical margin ("divergent").

b. Cœlonautilus Doohylensis, sp. nov. Plate XIX, figs. 3 *a*, *b*, 4 *a*, *b*.

Description.—Shell small (young ?), thick-discoid, rapidly increasing in diameter, with probably three or three and a half whorls, all exposed in a very deep umbilicus, the outer one with extremely steep, step-like sides. The section of the shell is distinctly quadrate, but somewhat wider than high, and it is tetragonal. The peripheral area is broad and very slightly concave in the centre; the margins are acute. The sides in the inner whorls are considerably narrower than the peripheral area, but in the body-chamber the reverse is the case, the sides increasing rapidly in diameter towards the aperture. The umbilical declivity in the body-chamber is very steep, and terminates at the edge of the peripheral area of the whorl it embraces.

The septa are not seen, but the form of the sutures can be made out from the base of the body-chamber; they are deeply concave on the sides of the shell, and form rather a deep, backwardly directed sinus upon the peripheral area.

The siphuncle is very small, and situated a little above the centre of the septum.

The ornaments consist of four, irregularly spaced, very fine, thread-like, longitudinal lines on each side of the peripheral area; lines of growth are also faintly discernible, crossing the peripheral area transversely.

Dimensions.

	Specimen from Rathkeale.
Diameter of shell	50 mm.
Height of whorl (dorso-ventral) . . .	21 ,,
Width of whorl	20 ,,
,, umbilicus (from edge to edge) . .	21 ,,
,, ,, (from suture to suture) .	19·5 ,,
Thickness of whorl at umbilical edge . .	24 ,,

Affinities.—It was at first thought that this shell might be the young of *C. planoterygatus*, but its much more rapid rate of increase, as evinced not only in the diameter of the sides but in the remarkable contrast in size between the last whorl and the one preceding it, entirely separates it from that species. I am not, however, able to say positively whether the specimen figured is a young or an adult one of its species, but the indications are in favour of its being the former; that is, there is no rounding off of the lateral angles indicative of the adult stage of growth, and its small size also suggests, though it does not of course prove, its immaturity.

From *C. gradus* the present species is easily distinguished by its more rapid rate of increase, and by the absence of the strong ridges ornamenting the peripheral area in the adult of that species (Pl. XIX, figs. 3 *a*, *b*). The two species are, however, clearly related.

Remarks.—The four specimens representing this species were all collected by me in a small mass of decomposing limestone in the railway cutting of the Limerick and Foynes Railway, near Rathkeale. The same fragment also contained many specimens of the young of *C. gradus*, A. H. Foord, an *Orthoceras* (*O. salvum*, L. G. de Kon.[1]), a small Gasteropod, and a species of Goniatite (*Pericylus Doohylensis*, A. H. Foord and G. C. Crick[2]), all admirably preserved and showing their finest ornamentation.

Locality.—Doohyle, county of Limerick.

c. Cœlonautilus gradus, *A. H. Foord.* Plate XX, figs. 1—9.

1891. Cœlonautilus gradus, *A. H. Foord.* Cat. Foss. Ceph. British Museum, pt. 2, p. 126, fig. 19.

1893. Strobоceras gradus, *A. Hyatt.* Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 411.

Description.—Shell thick-discoid, composed of two and a half or nearly three whorls, all exposed in a deep, step-shaped umbilicus, having a very large central vacuity. Section of the whorls distinctly quadrate and tetragonal. The peripheral area is broad and slightly depressed along the median zone, with two distinct keels on each side of it, one on the outer or lateral edge, the other just inside of this. Bordering the inner keel on each side there is a slight prominence, the space between these prominences forming a shallow depression. The sides are considerably narrower than the peripheral area; thus, where the latter is 18 mm. across, the former measure only 12 mm. In the young shell this discrepancy goes still further; thus, where the sides of the whorl are 5 mm. in width, the peripheral area is 9 mm. across. The sides are slightly convex, and slope outwards towards the umbilical margin (Pl. XX, fig. 4). They bear on the inner whorls faint transverse folds with dimple-like depressions between them; these become obsolete as the shell attains the adult stage. The body-chamber occupies about half a volution. Towards the aperture the peripheral angles become rounded off both in the young and in the adult shell; in the latter, distinct thick folds, forming tubercular elevations, may be developed on the peripheral border

[1] 'Calc. Carb. Belgique,' pt. ii, p. 67, pl. xli, fig. 6.

[2] 'Cat. Foss. Ceph. Brit. Mus.,' pt. 3, 1893, p. 151, fig. 72.

(Pl. XX, fig. 3), the keels having become obsolete or very faint. The aperture has a deep hyponomic sinus, on each side of which there are prominent lobes or crests (Pl. XX, figs. 3 and 6); viewed laterally it presents a graceful sigmoid curve (Pl. XX, fig. 3).

The ornaments of the test in the young shell consist of five irregularly spaced, exceedingly fine, thread-like longitudinal lines on each side of the peripheral area; these are replaced by two prominent keels in the adult shell, as already described. The whole surface is covered with very fine, transverse lines of growth, which form in the young shell minute, but quite distinct, crenulations in crossing the peripheral keel. In the adult shell they form a deep sinus upon the peripheral area, corresponding with that of the aperture. Upon the peripheral area of the adult shell a series of extremely fine longitudinal lines cover the two keels, but they do not extend beyond them laterally.

There appears to be no impressed zone in the young shell, but instead a slight flattening of the dorsal area is seen upon the inner whorl. The dorsal area of the initial volution (bordering the central vacuity) is raised into a faint median keel (Pl. XX, fig. 9), with other still fainter ridges on each side of it.

Upon the cast of the body-chamber in the adult shell the "Runzelschicht" is very distinctly preserved, consisting of rows of fine circular pittings arranged transversely to the longer axis of the shell.

The septa are extremely numerous, six occupying the space of 13 mm. near the body-chamber of an adult shell whose lateral diameter is from 11 mm. to 13 mm. at the place measured (Pl. XX, fig. 2). Upon the peripheral area of a young shell five occupy the space of 8 mm.; they here curve slightly backwards, as also upon the sides, making a sharp bend in crossing the angular margin (Pl. XX, fig. 7 *b*).

The siphuncle is situated in the upper third of the septum, maintaining this position apparently in all stages of growth (Pl. XX, figs. 4 and 9).

Dimensions.

	Adult.	Young.
Diameter of shell . . .	57 mm.	32 mm.
,, umbilicus (from edge to edge) .	32 ,,	21 ,,
,, ,, (from suture to suture)	26 ,,	15 ,,
,, central vacuity . .	? ,,	7 ,,
Height of outer whorl (dorso-ventral) .	19 ,,	11 ,,
Thickness of whorl at umbilical edge .	28 ,,	14 ,,

Affinities.—This species is most nearly related to *C. planotergatus*, from which it is distinguished by its slower rate of tapering, the strong keels upon the peripheral area, and the incipient folds upon the inner whorls. The width

of the peripheral area in comparison with that of the sides is also much greater than in *C. planotergatus*. From *C. subsulcatus*, Phill. sp., the present species differs in its less rapid rate of increase, closer septa, proportionately broader periphery, and much larger central vacuity.

Remarks.—The specimens which I regard as the young of the present species, several of which are figured on Pl. XX (figs. 5—9), are, I think, of considerable interest. I collected about a score of them in a piece of rock of such a size that it could easily be lifted. They are nearly similar in size (the largest only 35 mm. in diameter), several of them showing the margin of the aperture, proving them to be complete individuals. The rock, a decomposing limestone, easily yielded to the hammer, and thus its fossil contents were extracted with little difficulty, the only drawback being that the shells were so numerous and so close together that several had to be sacrificed in securing a few complete ones.

I had some hesitation at first in deciding that these small individuals were the young of *Cœlonautilus gradus*, A. H. Foord, rather than an independent species, but there appears to be sufficient data for this determination of them, though I have not enough material to justify me in breaking away the older whorls of *C. planotergatus*, and thus exposing the complete young shell for comparison with the small shells in question. An important point in favour of my view of their relationship to *C. gradus* consists in the presence of those peculiar incipient folds which are conspicuous in that species, and to this must be added the possession of a proportionally large central vacuity (cf. Pl. XX, figs. 1 *a* and 5). Furthermore, the form and proportions of the whorls in the small individuals are similar to those of *C. gradus*, so far as can be made out from the exposure of the inner whorls in the umbilical depression of a perfect individual, and from sections of the whorls in a broken one belonging to that species. Professor Hyatt regards this species as probably a member of his genus Stroboceras,[1] and he refers to the prominent transverse folds figured by me in the young whorls which show its affinities with *Trigonoceras*. The folds are faint, not prominent; the figure (*loc. cit.*, fig. 19) makes them too distinct. My own opinion is that it belongs properly to *Cœlonautilus*, and I think there is good ground for this view of its relationship when its general features are taken into account, and it is compared with the allied forms under which I have grouped it in this Monograph.

Localities.—Kildare (probably Clane); Rathkeale and Curraghbridge, county of Limerick.

[1] "Carboniferous Cephalopods." Second paper. 'Geological Survey of Texas, Fourth Annual Report,' 1892 (1893), p. 411.

Genus Stroboceras, *Hyatt*, 1883 (emend. 1893).

Group of Stroboceras sulcatum.

a. Stroboceras sulcatum, *J. de C. Sowerby*, sp. Plate XX, figs. 10—12.

1826. Nautilus sulcatus, *J. de C. Sowerby*. Min. Conch., vol. vi, p. 137, pl. dlxxi, figs. 1 (cast), 2 (young).
1836. — — *J. Phillips*. Geology of Yorkshire, pt. 2, p. 233, pl. xx, figs. 31, 32.
? 1843. — — *J. E. Portlock*. Geology of Londonderry, p. 404.
1844. — (Discites) sulcatus, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 19, pl. iv, fig. 14 (fig. not quoted in the text).
? 1860. Discites sulcatus, *R. Griffith*. Journ. Geol. Soc. Dublin, p. 561.
1891. — — *A. H. Foord*. Cat. Fos. Ceph. British Museum, pt. 2, p. 95.
1893. Stroboceras sulcatum, *A. Hyatt*. Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 411.
[*Not* 1844. Nautilus sulcatus, *L. G. de Koninck*. Desc. des Anim. Foss. du Terr. Carbonifère de Belgique, p. 545, pl. xlvii, figs. 10 *a*, *b*; 1878, Faune du Calcaire Carbonifère de la Belgique (Annales du Mus. Roy. d'Hist. Nat. de Belgique, tom. ii), pt. 2, p. 126, pl. xx, figs. 1—4.]

Description.—Shell discoid, compressed, of a lenticular form, composed of two and a half or three slightly embracing whorls, all of which are exposed in a rather shallow umbilicus, which has a small central vacuity; this is 4 mm. across in a ventro-dorsally compressed shell, whose diameter is 45 mm. (Pl. XX, fig. 11).

The apex or initial point is conical, and it is ornamented like the rest of the shell, the three ridges which occupy the most prominent elevation on the sides being developed upon it with proportional fineness.

The whorl in section is broadly sagittate, the periphery very narrow, slightly concave, and bordered by sharp keels. The sides are inflated in the lower two-thirds, with three or four fine spiral ridges upon the most prominent part, the lower keel forming the edge of the umbilicus. The upper third of the sides is divided by a narrow projecting ridge into two deep sulci, which are not quite so wide as the peripheral furrow.

The body-chamber occupies about half of the last whorl.

The septa are rather numerous, about twenty-six being contained in a complete whorl.

The siphuncle is situated very near the peripheral margin.

The surface of the test is covered by very fine and regular lines of growth, about six of which occupy the space of 1 mm. They are curved sigmoidally upon the sides, and form a deep, backwardly directed sinus upon the periphery, corresponding with the contour of the aperture. When the test is preserved these lines are easily seen with a lens of low power, and though merely lines of growth they are so regularly disposed as to constitute an important element in the ornamentation of the species.

Affinities.—This species is nearly related to *S. bisulcatum*, de Koninck, sp., but differs from it in having less compressed, transversely broader whorls, more strongly marked and persistent sulci on the sides, and rather closer septa. In a specimen of *S. bisulcatum* from Visé, Belgium, in the British Museum, the diameter of which is 42 mm., the height of the outer whorl is 16 mm., and its greatest thickness 11 mm. In Sowerby's type, fig. 2 of his plate (the specimen representing fig. 1 is lost), in the British Museum the measurements are—height of the outer whorl 10·25 mm., greatest thickness of the same 9 mm., the diameter of the specimen being 25·5 mm.

Comparing the septation of the two species, I find that in the inner whorls of an imperfect though undistorted specimen of *S. sulcatum* six of the septa occupy the space of 8 mm., whereas in one of de Koninck's figures ('Calc. Carb.,' pl. xxvii, fig. 7) of *S. bisulcatum* six septa fill the space of 10 mm. Without giving any measurements de Koninck states that the distance of the septa in these two species is about equal, though the septation in his figure shows the discrepancy just indicated. My statement ('Cat. Foss. Ceph. Brit. Mus.,' pt. 2, p. 95) that *S. sulcatum* has more distant septa than *S. bisulcatum* appears, therefore, to have been erroneous. It is to be regretted also that de Koninck gives no actual measurements, but only general observations, as above, on this point.[1]

Remarks.—The synonymy of this species which I have adopted requires explanation, and this can only be satisfactorily given by tracing its history. It was first described by Sowerby in the 'Mineral Conchology' (1829), the specific characters being incompletely given in the diagnosis, but treated with more fulness in the supplementary remarks which accompany it; both are here appended, as follows: "Discoid, minutely striated; whorls almost wholly exposed, ventricose, with two large furrows on each side and several small ones; front concave." It is further stated "the concave front is bounded by sharp edges; there is also a sharp elevation between the two furrows; the rest of the side is gibbose, with two or three very shallow broad furrows upon its most elevated part. The aperture is half as long again as it is wide, its sides of course indented; the siphuncle is

[1] I am indebted to the kindness of my friend Mr. G. C. Crick, F.G.S., for the measurements of the British Museum specimens given above.

placed just opposite to the inner indentation; the septa are numerous, with even edges."

The figures given by Sowerby represent a large cast and a very small specimen, in which the test with its ornaments is well preserved. The latter specimen is in the British Museum and is known to me.

Seven years later (1836) Phillips very briefly described a species under the name *Nautilus sulcatus*, Sowerby; his figure of it, though roughly sketched, adequately represents Sowerby's species, and there is nothing in the description, short as it is, to contradict the testimony of the figure.

In 1844 de Koninck[1] described as local varieties of *Nautilus sulcatus*, Sowerby, two species, one of which has been recognised as the *Nautilus sulcifer* of Leveillé;[2] for the other Hyatt has proposed the name *Stroboceras belgicum*.[3] Of this I shall have something further to say later on.

M'Coy's 'Synopsis' (1844), part of which appeared simultaneously with de Koninck's 'Description des Animaux fossiles,' &c., contains a most careful description and a figure of Sowerby's species such as leaves no doubt in my mind that the Irish form is identical with the English one. Unfortunately M'Coy in the description omitted all reference to his figure of the species ('Synopsis,' pl. iv, fig. 14), which is quite unaccountably named in the plate "*bisulcatus*," as if the author had intended to give the Irish shell that name, but had changed his mind, and, taking the more correct course, identified it with Sowerby's species. De Koninck[4] noticing this circumstance, and regarding M'Coy's species as distinct from Sowerby's, makes use of the name "*bisulcatus*," and constitutes M'Coy the author of the new species, which is founded, be it remarked, upon the figure only, de Koninck's reference being limited to the words 'Synopsis,' pl. iv, fig. 14. It should be mentioned here that the name "*bisulcatus*" is not contained in the list of M'Coy's species published in 1862 by Sir Richard Griffith, and appended to that issue of the 'Synopsis,' but there is this important piece of information to be gleaned from it. At p. 273 of the 1862 text[5] is a "note" containing a number of errata, not only concerning names of species, but also the numbering of the plates and figures. The "note" is as follows:

[1] 'Description des Animaux fossiles,' &c., p. 545.

[2] 'Cat. Foss. Ceph. British Museum,' pt. 2, 1891, p. 124.

[3] "Carboniferous Cephalopods." Second paper. 'Geological Survey of Texas, Fourth Annual Report, 1892' (1893), p. 411.

[4] 'Calc. Carb.,' p. 128, pl. xxvii, figs. 5—7, 9.

[5] I have called this the 1862 text or issue, but I do not mean to imply by this that it was a new edition; there is no warrant for such an assumption. I think that probably some sheets left over from the first (1844) issue were distributed with a new title-page, dated 1862. To this fresh issue Sir R. Griffith added his useful topographical and stratigraphical list of the Irish Carboniferous fossils, and thus supplied M'Coy's grievous omission of localities from his text.

"The reader will find it convenient to number the plates consecutively in manuscript according to the following corrections, as the references in the text very generally disagree with the numbers and contents of the plates in consequence of an oversight by which a *provisional nomenclature was accidentally retained in printing the plates*, the text having been subsequently written."

Now it would appear that de Koninck never saw this "note," for he writes under his description of "*Nautilus bisulcatus*" ('Calc. Carb.,' i, p. 128) that in the first copies of M'Coy's work that were distributed the syllable *bi-* prefixed to *sulcatus* in the plates had been erased, leaving only the latter name; and accounts for this verbal alteration by saying it was probable that during the printing of the diagnosis of the species M'Coy had changed his mind as to their names, which was no doubt the case, but did not, I think, justify de Koninck in adopting a name "*bisulcatus*," a name which, as described in the "note" above quoted, belonged to a "provisional nomenclature," appearing only in the list of names appended to the plate whereon the species was figured. I regard M'Coy's figure[1] as essentially agreeing with "*Nautilus*" *sulcatus*, with which I unhesitatingly associate it, Irish specimens that have come under my notice upholding me in this conclusion. I have one now before me from Little Island, Cork, which is the only locality for it given in Griffith's "Localities of Irish Carb. Fossils," arranged as an appendix to the 'Synopsis' (p. 228).

I will take the opportunity here of correcting the synonymy of *S. bisulcatus*, de Kon., sp. (*Discites bisulcatus*), in the 'Cat. Foss. Ceph. Brit. Mus.,' pt. 2, p. 96, by deleting, in conformity with the foregoing observations, the references dated 1844 and 1855. I would also call the attention of the reader to my "remarks" in the work just quoted.

The Belgian species differs from Sowerby's (in which I include the one described and figured by M'Coy) in its more compressed form, as demonstrated in the following table of measurements, in which it will be seen that the height of the outer whorl is much greater in proportion to the thickness in the specimen from Visé than in those from Cork, Ireland, and Castleton (?), England.

Dimensions.

	Sowerby's type, Brit. Mus. (young).	Little Isl., Cork.	Visé, Belg.
Diameter (approximate) of shell . .	25·5 mm.	41 mm.	42 mm.
,, ,, umbilicus (from edge to edge) .	?	22 ,,	?
,, ,, umbilicus (from suture to suture	?	15 ,,	?
Height of outer whorl (dorso-ventral) .	10·25 mm.	12 ,,	16 mm.
Thickness of outer whorl . .	9 ,,	$10\frac{5}{6}$,,	$11\frac{2}{3}$,,

[1] It is unfortunately the case that many of the specimens figured in the 'Synopsis' have been lost and amongst them the original of this figure.

It is also distinguished by having closer septa and less distinctly marked sulci than those in Sowerby's species.

It may not be superfluous to mention finally that I had not seen the 1862 issue of M'Coy's work when writing the 'Catalogue of the Fossil Cephalopoda' in the British Museum, no copy of it being contained in the library of that institution, and therefore, like de Koninck, I was then unaware of the existence of the "note" quoted above.

I have next to refer to Professor Hyatt's distribution of the group of forms to which the present species belongs. His observations upon them are very brief. Referring to *Stroboceras sulcatum*, J. de C. Sowerby, sp., he says, "This has smooth sides, is more compresed, and differs from the *Naut. sulcatus* of de Koninck, 'Calc. Carb.,' p. 27, for which I propose the name *S. belgicum*." The following European species are also referred to *Stroboceras* by Hyatt, *S.* (*Naut.*) *bisulcatum*, sp., de Koninck; *Phillipsianum*, sp., d'Orb., as figured by de Koninck; *Edwardsianum*, sp., de Koninck; *cordiostomum*, sp., de Koninck, and also *S.* (*Naut.*) *germanum*, Phillips, sp., as figured by d'Orbigny in the 'Paléontologie universelle,' pl. lxxxv.

I cannot understand upon what ground Professor Hyatt rests his statement that *Stroboceras sulcatum* has smooth sides; they are, on the contrary, beset with ridges and furrows, the more prominent of the former being quite conspicuous upon casts, even the lesser ridges not becoming obsolete till the body-chamber is reached.

Professor Hyatt does not indicate in detail the characters which separate *S. sulcatum*, J. de C. Sow., sp., from *S. belgicum*, A. Hyatt (= *N. sulcatus*, de Kon., *non* Sow.). The most obvious of them consist, firstly, in the relative dimensions of the whorl, which have already been tabulated; secondly, in the much larger size of the central vacuity in *S. belgicum*, conspicuous in one of de Koninck's figures ('Calc. Carb.,' pl. xxvii, fig. 2, selected by Hyatt as typical).

Localities.—Little Island, near Cork; Mullaghfarry and Crosspatrick, Killala, county of Mayo; Carnteel, county of Tyrone.

b. Stroboceras crassum, sp. nov. Plate XX, figs. 13 *a*, *b*, *c*.

Description.—The only specimen is a worn fragment of a portion of the body-chamber of a thick discoid shell, most of the test of which remains. It is subtriangular or broadly sagittal in section, abruptly truncated above, expanding rapidly to the margin of the umbilicus below. The periphery is narrow, but much wider than in related species (cf. *S. sulcatum*, J. de C. Sowerby sp., p. 59); it is very slightly, almost imperceptibly concave, and is bounded on each side by distinct marginal keels. The edge of the umbilicus is bordered by a keel, a

narrow furrow dividing the latter from a broad elevation on which there are the remains of two ridges, which have here nearly become obsolete, as is usually the case with the less prominent ornaments in this group of shells. Succeeding the elevation just mentioned is a broad and deep furrow, bounded above by a prominent rounded (in the worn condition of the specimen) ridge; between this and the peripheral border is another furrow, shallower than the one first described. The sides of the umbilicus descend very steeply to the sutural line of the preceding whorl. The impressed zone appears to have been shallow, but the test is wanting here. The lines of growth, which pursue the usual sigmoidal course transversely to the whorls, are but faintly visible here and there upon the test.

As the specimen is only a fragment of the body-chamber, neither the septa nor the siphuncle can be seen.

Affinities.—These are with *Stroboceras sulcatum*, J. de C. Sow., sp., but the great thickness of the fragment described clearly distinguishes it from that species, though it agrees therewith in the other features observable.

Dimensions.

	S. crassum.	*S. sulcatum.* (Sowerby's type, Min. Conch., vi, pl. dlxxi, fig. 2.)
Diameter of shell . . .	? mm.	25·5 mm.
Height of outer whorl (dorso-ventral) .	19 ,,	10·25 ,,
Thickness of whorl at umbilical edge .	17 ,,	9 ,,
Width of periphery where height of whorl is 15·5 mm.	7 ,,	Irish specimen of *S. sulcatum.* 4·5 mm.
Depth of umbilical wall of outer whorl (where height of whorl is 15·5 mm.) from edge to suture .	7·5 ,,	4 ,,

These comparative measurements bring out very markedly the much greater thickness of the species under description, when compared with *S. sulcatum*.

Locality.—Ring, near Enniskillen, county of Fermanagh.

Genus Apheleceras, *Hyatt*, 1883 (emend. 1893).

Group of Apheleceras mutabile.

a. Apheleceras mutabile, *F. M'Coy*, sp. Plate XXI, figs. 1—3.

1844. Nautilus (Discites) mutabilis, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 18, pl. iii, fig. 7.

1860. Discites mutabilis, *R. Griffith*. Journ. Geol. Soc. Dublin, vol. ix, p. 77.

1878. Nautilus mutabilis, *L. G. de Koninck.* Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, Paléont., tom. ii), pt. 1, p. 121, pl. xxv, figs. 2 *a—c.*

1891. Discites compressus, *A. H. Foord.* Cat. Foss. Ceph. British Museum, pt. 2, p. 91, fig. 11 (*not Ellipsolites compressus*, J. Sowerby, Min. Conch., 1813, vol. i, p. 84, pl. xxxviii).

1893. Apheleceras mutabile, *A. Hyatt.* Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 413.

Description.—Shell of a very distinctly discoid shape, the sides tapering rapidly towards the periphery; much compressed; composed of three and a half to four quickly increasing volutions, the sides of which are completely exposed in a wide and shallow umbilicus, with a rather large central perforation. The section of the whorls in the adult shell is hexagonal, or, taken as a whole, sagittate with truncated apex; in the young the umbilical angles are inconspicuous, and the dorsal or anti-peripheral area is rather more rounded. The initial point is conical, and is sometimes detached from the second whorl (de Koninck). As the shell grows the umbilical walls become gradually deeper and somewhat concave, the suture of the shell having sometimes a slight rim in the last whorl. The edge of the umbilicus forms a thick, rounded angle owing to a thickening of the shell substance. The sides are slightly inflated in the adolescent stage but become flat in the adult; they terminate at the edge of the periphery in a sharp and prominent keel; the periphery is deeply concave and very narrow. The impressed zone is marked by a median ridge bordered by two grooves corresponding with the ventral furrow and its bordering keels. The body-chamber occupies a little more than half the last whorl; it becomes separated from the penultimate whorl in adult individuals for a distance of 18 mm. to 38 mm.

The septa are very numerous and deeply concave; thirty-six can be counted to one whorl in a shell whose diameter is 93 mm. (Pl. XXI, fig. 3). Where the whorl has a dorso-ventral diameter of 22 mm. they are 6 mm. apart, at a diameter of 15 mm. their distance is reduced to 5 mm., and again at a diameter of 7 mm. they are 3 mm. apart (Pl. XXI, fig. 3). Their distance apart is thus very gradually augmented. The sutures make rather a deep backward curve on the sides of the shell and on the periphery.

The siphuncle is a little above the centre, and maintains that position throughout the whole growth of the shell.

Ornamentation is only developed in the young shell; it consists of fine and regular longitudinal ridges covering the sides, and, to a certain distance, and more sparsely, the dorsal area. About eight of these ridges occur where the whorl, bordering the central vacuity, has a diameter of 5 mm.; they are strongest and

most prominent near the suture of the shell, and become gradually finer from this point to the edge of the cavity; they are continued upon the dorsal area, but here they are again much finer, and become obsolete at a short distance from the initial point, at a place where the shell measures about 4 mm. across the sides. The ridges are crossed by very fine and close-set lines of growth, making a delicate and beautiful cancellated sculpture. This sculpturing is not continued beyond the innermost volution, and scarcely lasts for a complete whorl, the test becoming abruptly smooth or marked only by feeble lines of growth, except upon the periphery, where these lines are regular and very crowded, making a sinus which bends sharply back in conformity with the edge of the aperture.

Dimensions.

	Specimen from Clane in the Museum of Science and Art, Dublin.
Diameter of shell[1]	111 mm.
,, umbilicus (from edge to edge)	60 ,,
,, ,, (suture to suture)	51 ,,
Height of outer whorl (dorso-ventral)	35 ,,
Width of periphery of outer whorl	12 ,,
Thickness of shell at umbilical edge	25 ,,
Depth of umbilical wall	5 ,,

The rapid increase in the growth of the shell is very strikingly shown by measuring the whorls transversely, from the inner to the outer whorl, when the figures are as follows: 5 mm., 14 mm., 35 mm.

A very large specimen in the Museum of Science and Art, Dublin, yields the following measurements: diameter of the shell, 123 mm.; that of the umbilicus, 68 mm.; height of outer whorl, 38 mm.

Affinities.—The most nearly related species is *Apheleceras discoideum*, de Kon., sp.,[2] but this is easily distinguished from the present species by its much more compressed form, and by the spiral ridges which extend to the beginning of the last whorl. Another related form is *Apheleceras difficile*,[3] de Kon., sp., in which the whorls are much wider transversely; they also overlap the preceding ones to a much greater degree than is the case in *A. mutabile*, and the central vacuity is much smaller and the septa more numerous than in the latter. *A. trochlea*, M'Coy,[4] also bears some relationship to *A. mutabile*, but it is distinguished by its

[1] The specimen measured has been rendered somewhat elliptical, apparently through rock pressure, which has operated in a direction contrary to that of the spiral axis of the whorls.

[2] 'Faune Calc. Carb. Belg.,' pt. 1, p. 133, pl. xxv, fig. 3.

[3] Ibid., p. 118, pl. xxvi, fig. 5.

[4] 'Synop. Carb. Foss. Ireland,' 1844, p. 19, pl. iii, fig. 4.

much thicker proportions, and transversely broader whorls. *Nautilus Mosquensis*, Tzwetaev[1] (= *subsulcatus*, Trautschold, *non* Phillips) somewhat resembles the present species, but the periphery is broader and not so concave, and the sutures are not so sinuous. *A. hibernicum*, A. H. Foord and G. C. Crick,[2] is closely allied to *A. mutabile*, but differs from it in its less slender proportions, less deeply channelled periphery, and in the non-contiguous condition of the first half-whorl.

Remarks.—In the 'Catalogue of Fossil Cephalopoda, British Museum,' pt. 2, 1891, p. 91, *A. mutabile* is included in the synonymy of a species described by J. Sowerby under the name of *Ellipsolites compressus*.[3] It was afterwards discovered, however, by Mr. G. C. Crick and the writer that Sowerby's species was identical with the one described by that author as *Ammonites Henslowi*,[4] and it was further ascertained that *Ellipsolites compressus* (= *Ammonites Henslowi*) was a Goniatite belonging to the genus *Prolecanites*, Mojsisovics. This correction was published with full details and illustrations of the species in the 'Geological Magazine' for January, 1894, and subsequently in the 'Cat. Foss. Ceph. British Museum,' pt. 3, 1897; this allusion to the subject will therefore be sufficient.

Localities.—Rathfarnham, county of Dublin; Clane and Naas, county of Kildare; Cregg, near Nobber, county of Meath; Little Island, near Cork; Rathkeale, county of Limerick

b. Aphelecras Hibernicum, *A. H. Foord and G. C. Crick.* Plate XXI, figs. 4—7.

1893. Discites Hibernicus, *A. H. Foord and G. C. Crick.* Geological Magazine, dec. 3, vol. x, p. 251 (woodcut, p. 254).

Description.—Shell discoid, compressed; whorls three (in largest individual measured), rather slowly increasing, the first half-whorl free, the rest in contact, but leaving the sides of the inner whorls entirely exposed; the impressed zone faintly defined on the body-chamber. The latter occupies fully one-half of the last whorl, and becomes free towards the aperture. Section of the whorl subcircular in the young, but becoming truncated-cuneiform and tetragonal in the adult. Umbilicus broad and shallow, with a large central vacuity; its walls sloping in such a degree as to form a very obtuse angle with the sides of the shell. Periphery convex in the free portion, concave in the last whorl, about one-half of the width of the side, exclusive of the umbilical slope; bounded on each

[1] 'Mém. Comité Géol. [Russia],' vol. v, No. 3, 1888, p. 52.
[2] 'Geol. Mag.,' decade 3, 1893, vol. x, p. 251 (woodcut).
[3] 'Min. Conch.,' vol. i, 1813, p. 84, pl. xxxviii.
[4] Ibid., vol. iii, 1820, p. 111, pl. cclxii.

side by a narrowly rounded, not very prominent rim. The sides are flattened in the adult stage, and converge rather rapidly from the umbilical edge towards that of the periphery.

The apex is bluntly conical and subcircular in section; the extremity is not seen in any of the specimens examined, but at a point which must be very near it the diameter is 2·5 mm., the ornaments being here quite clearly defined. The whorls begin with what Prof. Hyatt would describe as a gyroceran curve, which remains free to the extent of fully half a volution before the succeeding one comes in contact with it.

The septa (here described from a fragment which shows them only in the adolescent stage of the growth of the shell) are numerous, the sutures indicating by their curvature that the chambers were rather deep. Where the whorl has a transverse diameter of 9 mm. the sutures are from 3 mm. to 3·5 mm. apart; where this diameter has increased to 15 mm. the sutures are from 4 mm. to 5 mm. apart. At this (adolescent) stage of growth there are thirty-two septa in a whorl whose diameter is 55 mm.

The siphuncle occupies a position slightly above the centre of the septa; its diameter is not known, as it is only seen at the base of a fragment of the body-chamber.

The ornamentation consists primarily of a series of well-defined longitudinal (or spiral) ridges, which become more widely separated in proportion to the increase in diameter of the whorls; these ridges, crossed transversely by fine lines of growth, become thus minutely but distinctly crenulated. The lines of growth make a very deep and narrow, backwardly directed sinus in crossing the periphery, being here very close-set and regular. The longitudinal ridges are most strongly developed upon the sides of the shell, they tend to die off on the dorsal area, and disappear entirely on the completion of the first two whorls, or thereabouts.

Dimensions.

	Type specimen. (Brit. Mus.)	Large specimen. (Mus. Sci. and Art, Dublin.)
Diameter of shell	72 mm.	115 mm.
,, umbilicus (from edge to edge) about . .	42 ,,	60 ,,
,, ,, (from suture to suture)	33 ,,	55 ,,
Height of outer whorl . . .	24 ,,	38 ,,
Width of periphery of outer whorl . .	10 ,,	—
Thickness of shell at umbilical edge about .	21·5 ,,	—

Affinities.—This species is very similar in many respects to *A. mutabile*, M'Coy, sp., differing therefrom in the free condition of the first whorl, in the

much less deeply channelled periphery, in the crenulated character of the ornamentation of the inner whorls, and finally in its less compressed form.

It also resembles *A. discoideum*, de Kon., sp., but it tapers more rapidly, has much more numerous ridges, a less deeply channelled periphery, and the first whorl free. The sides also in *A. hibernicum* are more strongly convergent towards the periphery than those of *A. discoideum*, or, in other words, the latter has a more compressed shape.

Remarks.—This shell has been met with, up to the present time, only in the quarries at St. Doulagh's, where it is tolerably abundant. It is easily distinguished, even in fragments, from *A. mutabile* by its less compressed form and less deeply channelled periphery. In the young shell the first whorl being out of contact with the succeeding one is a distinctive feature.

A cast of the body-chamber shows at the base very distinct impressions of the shell-muscle as well as indistinct marks of the "Runzelschicht" (or "wrinkle layer;" marks supposed to represent the surface of the mantle of the animal). The former consist of two incised lines which are 3 mm. apart on the sides of the shell, getting gradually nearer towards the angles of the whorl. They follow in their course the contour of the last septum, whose outline is also impressed, rather faintly, upon the cast. There is also a series of short longitudinal indentations, crowded together, on the dorsal area situated in advance of, but almost touching, the incised lines of the shell-muscle. These have precisely the appearance produced by impressions of the thumb-nail when lightly applied to a soft substance, such as modelling wax. They doubtless served to strengthen the hold of the muscle to the shell, and recall similar points of attachment observed in *Cœlonautilus*,[1] as well as in the recent *Nautilus*.

Locality.—St. Doulagh's, county of Dublin.

. Apheleceras trochlea, *F. M'Coy*, sp.

1844.	Nautilus (Discites) trochlea, *F. M'Coy*.				Synop. Carb. Foss. Ireland, p. 19, pl. iii, fig. 4.
1855.	—	—	—	—	British Palæozoic Foss., Fasc. iii, p. 561, pl. iii H, fig. 16.
1878.	—	trochlea, *L. G. de Koninck*.			Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, Paléont., tom. ii), pt. 1, p. 119, pl. xxvi, fig. 4.
1893.	Apheleceras trochlea, *A. Hyatt*.				Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 414.

[1] 'Cat. Foss. Ceph. British Museum,' pt. 2, 1891, p. 106, fig. 15.

Description.—"Discoid, of two and a half rapidly enlarging whorls, almost entirely exposed in an umbilicus with vertical sides; sides of the shell nearly flat, sloping with slight convexity from the rectangular edge of the umbilicus to the narrow, deeply concave periphery, which is bounded by two acutely angular edges; mouth widely trigonal, notched at apex by the concavity of the periphery; septa moderately numerous, having a broad backward curve on the sides, and a more abrupt one on the periphery, the two separated by an acute forward angulation on the lateral edge of each side; last chamber occupying nearly half of the body-whorl. Diameter five inches, proportional diameter of umbilicus $\frac{36}{100}$, antero-posterior diameter of mouth $\frac{44}{100}$, width of penultimate whorl $\frac{15}{100}$, width of mouth at outer edge of umbilicus $\frac{38}{100}$, width of concave periphery at mouth $\frac{14}{100}$" (M'Coy, 1855).

Remarks.—The species here described by M'Coy, first in his 'Synopsis' and afterwards in the 'British Palæozoic Fossils,' is represented in the "Griffith Collection" (Science and Art Museum, Dublin) by the fragment of a body-chamber figured in the first of these works (*loc. cit.*), the only specimen found, up to the present time, in Ireland. The more perfect specimen, above described, came from Kendal, Westmoreland.

The fragment is a cast of part of the body-chamber with the anterior portion broken off; it formed part of a very large individual, as the following measurements indicate: height of whorl (dorso-ventral) at anterior end 62 mm., at posterior end (a distance of 100 mm.) 50 mm., width of periphery at anterior end 24 mm., at posterior end 17 mm. Upon a chord of 100 mm., subtending the convex side, the greatest curvature is 15 mm.

The fragment is broken away on one side; on the other the side is very slightly convex and slopes gently from the umbilical to the peripheral border. The periphery is deeply concave, and, judging by the acute edge of the cast on each side of it, had prominent keels. A fragment of the test remains upon the periphery; it is almost covered by an encrusting Polyzoan; fine transverse lines of growth can, however, be seen bending backwards, but there are no longitudinal lines.

This species bears a strong resemblance to *A. exaratus*, de Kon., sp.,[1] a circumstance which was not overlooked by de Koninck in describing his species. The points of difference between them appear to be in the relative width of the peripheral and dorsal areas; thus in *A. exaratus* these areas are more nearly equal in width than in *A. trochlea*, or, in other words, the sides are more divergent from the periphery to the umbilical edge in the latter species than they are in the former. De Koninck also remarks that the form of the section in *A. exaratus* is

[1] "Faune Calc. Carb. Belgique," pt. 1, p. 120, pl. xxv, figs. 1 *a*, *b*.

more rectangular in *A. trochlea*, which naturally results from the greater divergency of the sides in the latter species just referred to.

Locality.—Cookstown, county of Tyrone.

Mesochasmoceras,[1] gen. nov.

The first whorl forms a very wide curve, leaving an unusually large central vacuity which is the most striking feature of this genus, none other approaching it in this particular. The shell is throughout greatly compressed, as shown in the ratio of the two diameters of the section, the height being to the thickness respectively as 20 : 12. A third characteristic of great importance is the complete absence of ornamentation at all stages of growth. This differentiates it from *Apheleceras*, which it at first sight resembles, and to which it is apparently allied.

The young shell is nearly ovate in section, but before the first whorl is reached it becomes angular on the peripheral and umbilical borders. Before the completion of the first whorl the periphery gets flattened and the sides compressed (cf. Pl. XX, fig. 15 *d*), an imperfectly defined lateral angle being developed, which persists throughout the growth of the shell, but never becomes sharply defined. The overlapping of the whorls is so slight as not to extend beyond the borders of the periphery.

The septal characters are but imperfectly known, my material not being sufficient to enable me to make a complete study of them (Pl. XX, fig. 14 *b*).

The siphuncle is seen only in section (Pl. XX, figs. 15 *c*, *d*).

It will be useful here to tabulate the principal characters of *Mesochasmoceras*, and to place in contrast with them those of *Apheleceras* (Pl. XXI, figs. 1—7), thus:

Mesochasmoceras.	*Apheleceras.*
Whorls greatly compressed.	Whorls compressed.
Periphery a little narrower than the sides; slightly channelled.	Periphery extremely narrow; deeply channelled.
Umbilical vacuity excessively large.	Umbilical vacuity moderately large.
Test unornamented throughout.	Test ornamented in the young stage.
Ratio of height to thickness of whorl, respectively as 20 : 12.	Ratio of height to thickness of whorl, respectively as 25 : 20.

The genus *Mesochasmoceras* falls under Hyatt's family Trigonoceratidæ, which includes the following genera: *Trigonoceras*, M'Coy; *Calonautilus*, Foord,

[1] From μεσοχάσμα, an opening in the middle; κέρας, a horn.

emend. Hyatt; *Stroboceras*, Hyatt; *Aphelaceras*, Hyatt; *Mesochasmoceras*, Foord; *Subclymenia*, d'Orbigny; *Diorugoceras*, Hyatt (of doubtful validity, the single species [*infra*, p. 74] upon which it is founded being very imperfectly known).

MESOCHASMOCERAS LATIDORSATUM, *F. M'Coy*, sp. Plate XX, figs. 14 *a*, *b*, 15 *a*—*d*.

1844. NAUTILUS LATIDORSATUS, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 18 pl. iv, fig. 16.

Description.—Shell discoid, much compressed, with about two and a half volutions, the sides of which are entirely exposed in a large and very shallow umbilicus which has a remarkably large central vacuity. The section of the whorl, scutiform in the young, becomes in the adolescent stage of growth subquadrate and tetragonal, the adult becoming more compressed from side to side and hence more elongate dorso-ventrally. The zone of impression is slight and its boundaries faintly defined. The initial point of the apex is not seen, but the shell is present in one individual examined up to a very short distance from it, and measures where broken off 1·5 mm. in its dorso-ventral diameter, and 1 mm. in the transverse direction. The section of the young shell is nearly ovate, the angularities afterwards developed not being present at this stage. Before the first whorl has been attained the periphery becomes flattened, the dorsal or antiperipheral area, however, still remaining rounded, and it is not until the second whorl has begun that a faintly defined lateral angle or shoulder begins to be formed; this gradually becomes more distinct, and constitutes a definite, though never sharply defined angle to the umbilicus, whence the whorl slopes down to the suture formed by contact with the preceding whorl. The periphery which is narrow now becomes concave, but not deeply so, and it is bordered on each side by an inconspicuous keel. The sides, after the young stage of the shell is past, are flattened, or slightly convex, a faint depression being formed in the adolescent (neanic) stage near the keel, giving the latter more prominence at this part of the shell. The overlapping of the whorls does not extend beyond the peripheral margin.

The body-chamber occupies about half of the last volution.

The septa are moderately distant, and the curvature of their sutures indicates that the chambers were rather deep (Pl. XX, fig. 14 *b*). The sutures are 4·5 mm. apart where the transverse diameter of the whorl from the edge of the periphery to the suture of the shell measures 12 mm., this distance being reduced to 3 mm. where the diameter, similarly measured, is 11 mm.

The siphuncle is situated slightly above the centre of the septum.

The surface of the test is smooth, only some obscure folds being present here

and there on the umbilical declivities. Lines of growth on the sides of the shell, mostly too fine to be seen except with a lens, are more easily discernible on the periphery, where they are crowded together, forming a deep, backwardly directed, and sharply bent sinus; some very obscure longitudinal lines occur also here.

Dimensions.	Large individual from Rathkeale. (Science and Art Museum, Dublin.)
Diameter of shell, rendered somewhat elliptic by pressure	73 mm.
,, umbilicus (from edge to edge) . .	46 ,,
,, ,, (from suture to suture) .	35 ,,
Height of outer whorl (dorso-ventral) . .	18·5 ,,
Width of periphery of outer whorl . . .	8·5 ,,
Thickness of shell at umbilical edge . . .	13 ,,

Remarks.—M'Coy's description of the present species was drawn up from a specimen half buried in the rock;[1] it is contained in the Museum of Science and Art, Dublin ("Griffith Collection"). He states that there are "very faint traces of spiral striæ on the inner or young volutions," but, with much more perfect material than M'Coy had, I have failed to see any such ornamentation, nor is it to be seen in the type specimen from which M'Coy's description was, presumably, drawn up.

Localities.—Clane, county of Kildare; Argoul South and Cragard, county of Limerick.

Genus Diorugoceras, *Hyatt*, 1893.

Diorugoceras planidorsatum, *J. E. Portlock*, sp.

1843. Nautilus planidorsatus, *J. E. Portlock*. Geology of Londonderry, p. 403, pl. xxxv, fig. 1.

1893. Diorugoceras planidorsatum, *A. Hyatt*. Carboniferous Cephalopods. Geological Survey of Texas, Fourth Annual Report, 1892, p. 416.

As will be seen from Portlock's description here given, this is a very problematical form, and the utility of dealing with it afresh is perhaps open to question; were it not that Professor Hyatt has proposed a new genus for its reception, I should probably have passed it by, as I have not access to the specimen, and am not even aware of its present location.

[1] It is drawn on the plate free from the matrix; the form and dimensions of the specimen, however, leave no doubt in my mind as to its representing the specimen in the "Griffith Collection."

Portlock begins his description by comparing his species with a Goniatite:

"A larger and flatter shell than Professor Phillips's,[1] which is described as 'very depresssed' back (in adults) truncate; umbilicus open; fine transverse bent striæ." Professor Phillips's species was about half the size of this, and the back is represented as quite flat; in this it is slightly concave and narrower. The sides are much flattened; and the umbilicus, represented by Phillips as open, but very small, is evidently in this also very small, if not entirely closed.

"The surface is not sufficiently preserved to exhibit striæ; but the septa can be traced, and appear more suitable to the Nautiloid than Goniatitic type. Diameter of disc 3·5 inches, thickness at back ·3 of an inch; sides much flattened; outer edge shallow concave; septa very concave.

"This differs from *Nautilus sulcatus*, and some other species with flattened or concave backs, by the volutions being concealed.

"*Locality.*—Derryloran, Tyrone, in light pinkish limestone."

Family Triboloceratidæ.

Genus Triboloceras, *Hyatt*, 1883 (emend. 1893).

Triboloceras formosum, sp. nov. Plate XXII, figs. 1, 2.

?1844. Temnocheilus crenatus, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 21, pl. ii, fig. 9 (fragment).

Description.—Shell discoid, composed of two volutions having a very deep funnel-shaped umbilicus with a large central vacuity. The whorls, hexagonal in section in the young, become digonous in the adolescent and adult stages. The body-chamber occupies apparently half a volution. It is slightly detached from the preceding whorl near the aperture.

The periphery in the young and adolescent stages is broad, and is divided into three distinct zones, the centre being occupied by a low median elevation, bounded on each side by shallow furrows; ridged elevations, which are a little higher than the median one, fill the spaces on each side of the furrows and slope downwards to the keeled umbilical margin. From the latter there is an abrupt slope to the suture of the shell.

[1] "*Goniatites truncatus*," Phill., 'Geology of Yorkshire,' pt. 2, 1836, p. 234, pl. xix, figs. 20, 21 (= *Glyphioceras truncatum*, Phill., sp., 'Cat. Foss. Ceph. British Museum,' pt. 3, 1897, p. 175, fig. 82).

As the shell grows towards the adult stage the median elevation becomes depressed and indistinct and gradually almost obsolete, the strong ridges on each side of it disappearing entirely in the senile stage, the body-chamber being here quite smooth. The umbilical declivities—for in this species there are no "sides," strictly speaking—are gently curved, becoming somewhat steeper when the body-chamber is reached. The zone of impression, which can only be seen on the body-chamber of one of the specimens before me, is so shallow as to be scarcely perceptible. It must be more pronounced in the young shell in which a median peripheral elevation is developed, as already described.

The septa are not seen, the only indication of their form, and that an imperfect one, being the impression left by the suture-line at the base of the body-chamber. Here, occupying the centre of the periphery, their outline describes a broad and shallow sinus, whose convexity is directed towards the aperture; this sinus is bounded on each side by an acute, posteriorly pointed lobe, the outline of which is continued obliquely upwards and outwards till it reaches the peripheral margin, at which point it bends backwards in a brief curve upon the extremely narrow zone representing the sides of the shell. The curvatures and lobes here described are coincident with and originate from the elevations and furrows developed upon the periphery.

The siphuncle is situated apparently a little above the centre. It is very obscurely seen, owing to the spaces between the septa being filled up with calc-spar.

The ornamentation consists of longitudinal ridges of variable strength. Upon the dorsal or anti-peripheral area of the adult shell there are none; my material does not enable me to say whether the young shell had any upon this part. There are four upon the umbilical declivity, the two lower being less prominent than the upper ones; the space between the lowest ridge and the one immediately above it is slightly wider than that between the other ridges. A very strong and prominent ridge forms the edge of the umbilicus, and at the same time that of the periphery; this is acute in the young shell, but it becomes rounded as the shell attains maturity, till finally in the senile stage it is obsolete, its position being marked only by a slight elevation.

The periphery in the young shell has eight ridges, excluding those forming its border; three of them are on each side of the median elevation, the inner ones forming the boundary of the furrows; the latter are shallow; the median elevation is not quite as high as the lateral ones; down its centre are two ridges which are much less prominent than those on each side of it, and as the shell grows they gradually become obsolete at about the end of the first whorl. The lateral ridges of the periphery appear to extend as far as the body-chamber, but to what length they go beyond this I am unable to say, as the test is not preserved upon

the latter excepting a small portion of it near the aperture, where it is quite smooth.

The whole of the surface of the shell is covered with fine transverse lines of growth, which, in crossing the ridges, are thickened into small but conspicuous nodes which are somewhat elongated transversely. This crenulation gives a characteristic appearance to the ornamentation, which hence resembles that of *Vestinautilus semiglaber* (Pl. XXII, figs. 3, 4 *a*, *b*).

Dimensions.

	Adult specimen from Lisbane, Limerick.
Diameter of shell . . .	100 mm.
,, umbilicus (from edge to edge) .	79 ,,
,, ,, (from suture to suture)	43 ,,
Height of outer whorl (dorso-ventral) about .	35 ,,
Width of periphery of outer whorl . .	60 ,,

Affinities.—It is possible that the fragment of a body-chamber from Tirlecken, Shrule, county of Longford, described by M'Coy under the name of *Temnocheilus crenatus*, may belong to the present species, but its imperfect condition will leave this always a matter of uncertainty. M'Coy's specimen is in the "Griffith Collection" of the Science and Art Museum, Dublin.

Allied to *Triboloceras formosum* is *T. Meyerianum*, de Koninck, sp.; the distinctions between them are, however, quite clear. The section of the whorls (adult) in the latter is distinctly scutiform, the height in proportion to the width being much greater than in *T. formosum;* thus in the latter, where the height (dorso-ventral) of the whorl is 31 mm., the width, or lateral diameter, is 50 mm. In *T. Meyerianum*, where the height of the whorl is 44 mm., the width is 48 mm., a very slight difference compared with that which obtains in *T. formosum*. Another element of divergence between the two species is to be found in the ornaments, the ridges on the periphery in *T. Meyerianum* being differently disposed from those of *T. formosum;* those of the former are greatly elevated in the median line, four of the ridges standing out with great prominence and giving a pointed aspect to this part of the shell. The ridges upon the umbilical declivities are also more numerous in *T. Meyerianum* than in *T. formosum*.

Remarks.—This handsome shell, though here assigned to *Triboloceras*, seems to be a passage form between that genus and *Vestinautilus;* its very deep, crateriform umbilicus and broad periphery connecting it with the latter, from which, however, it is distinguished by the digonous form of its whorls and the numerous and prominent longitudinal ridges ornamenting its surface. It has, moreover, been remarked by Prof. Hyatt that *Triboloceras Meyerianum* is a

specialised form of the group (I have already pointed out its close affinities with *T. formosum*), having a broad, elevated, median ventral (peripheral) zone. This feature is strongly characteristic of *Vestinautilus*, though it is not shared in by all the species of that genus—*V. Koninckii*, A. d'Orbigny, *V. cariniformis*, A. Hyatt, *e. g.*, having a concave peripheral area, just as *T. Meyerianum* has, contrary to its congeners *T. serratum*, *T. consobrinum*, and *T. intermedium*, a convex one.

Localities.—Lisbane, county of Limerick; Garrihies, county of Kerry.

Genus Vestinautilus, *Ryckholt*, 1852 (emend. *Hyatt*, 1883, 1893).

Vestinautilus semiglaber, sp. nov. Plate XXII, figs. 3, 4 *a*, *b*, *c*.

Description.—Shell somewhat thick-discoid, consisting of about four volutions, deeply umbilicated, with a small central vacuity. The whorls increase rapidly in diameter, their section is subhexagonal. The ventral area is broad and slightly arched, the sides are flattened, and are only slightly inclined inwards, the edge of the umbilicus is subangular, its walls sloping towards the centre, thus forming an obtuse angle with the sides; the zone of impression is shallowly concave with an acute edge. The whorls in the young shell are, as usual, somewhat rounded, and do not assume the angular form of the sides until after the first whorl has been reached. The body-chamber (not quite complete anteriorly in the only specimen which shows it) occupies perhaps rather more than half a volution. It increases very rapidly in diameter, the width at the base of the cast being about 25 mm., measured across the ventral area; that at the apertural extremity being about 35 mm. in the same relative position.

The margin of the ventral area, as seen in the cast, projects outwards on each side of the body-chamber, in the vicinity of the aperture; a sensible contraction taking place in front of the projections, and a marked thickening of the test, causing an elevation in its surface, is seen just below the cast of one of these projections on the angular border of the umbilicus.

The zone of impression is shallowly concave, and bordered on each side by a prominent keel; within the keels there are two fine incised lines caused by the ridges on the periphery of the whorl embraced; the lines of growth upon the latter are also distinctly reproduced.

The septation in this species cannot be completely described, as it is only seen imperfectly in the adult; the sutures are 6 mm. apart in the last two septa; in the young shell the septa are 2·5 mm. apart where the diameter of the whorl, as nearly as can be made out, is about 5·5 mm. The siphuncle is not seen.

The ornamentation is both strongly marked and very beautiful. It consists

primarily of a series of ridges or keels extending from the margin of the umbilicus to that of the ventral area. These ridges, which are beautifully crenulated by the lines of growth which cross them transversely almost at a right angle, vary in strength and distance apart. There are nine of them; those of the umbilical margin, of which there are three, being the strongest, the other six becoming finer as they approach the ventral border. The widest space between the ridges is about the middle of the lateral area; on either side of this zone they are closer together. This description is drawn up from the test on the body-chamber of an adult (?) specimen; the ridges are more regularly spaced on the test of the adolescent stage. The ridge just inside the umbilical border is quite strong in the adult shell, in the adolescent it is exceedingly faint. There are four ridges on the peripheral area, viz. two on each side, near its border, the inner ones being exceedingly fine thread-like lines. These ridges are quite distinct in the young shell, but in the adult the inner ones disappear upon the body-chamber.

A marked feature in the ornamentation is the smoothness of the zone encircling the umbilical cavity below its margin and extending from thence to the suture or line of junction with the preceding whorl. I have called this zone smooth, though there is a faint ridge or flattened band encircling it in the adolescent shell, but this compared with the strong, crenulated lateral ridges may well be neglected.

Affinities.—I am not at all confident that the generic position of the present species is correctly determined; it certainly approaches nearest to *Vestinautilus* in the configuration of the whorls, and especially in the form and the ridged character of the periphery. The wide lateral areas, so strongly ridged, with the smooth, unornamented umbilical declivities are, however, features without a parallel in that genus. Naturally, the question as to what species it is most nearly related to is still more difficult to decide, as none resembles it sufficiently to warrant any strict comparison being made. The species must remain for the present isolated.

Remarks.—This very beautiful species was found at Lisbane, in the county of Limerick, associated with the species I have called *Triboloceras formosum*. Only two specimens were collected; both of them are in the Museum of Science and Art, Dublin (Collection of the Geological Survey of Ireland).

Locality.—Lisbane, county of Limerick.

VESTINAUTILUS CRASSIMARGINATUS, sp. nov. Plate XXII, figs. 5 *a*—*c*.

Description.—Shell discoid, with slowly increasing whorls, all exposed in a deep umbilical cavity having a large central vacuity. The whorls are digonous

in section, the peripheral area making a broad flattish arch; the sides, which form the steeply descending umbilicus, diverge at an obtuse angle from the margin of the latter; they are somewhat inflated in the lower half and slightly concave in the upper, resembling those of *Vest. cariniferus* in this respect. The contact or inclusion of the whorls is very slight, and, so far as can be made out from a section, there is no perceptible zone of impression. Owing to this slight amount of overlapping of the whorls, part of the peripheral area is exposed in the umbilicus, the inner whorls thus making a deep channel where they abut against those that embrace them. The umbilical border is marked by a strong, rounded rim, which becomes very prominent in the adult and senile stages.

In the young shell the rim is about as prominent as it is in the adult of *Vest. cariniferus*, J. de C. Sow., and other allied species. The conical apex of the young shell is ornamented with a series of close-set, fine, longitudinal ridges, and these are crossed by minute transverse striæ, which, cutting the former, impart a beautifully crenulated appearance to this part of the shell as seen under the lens. After the first whorl is passed the spiral lines begin to widen, and those of the lower half of the whorl entirely disappear, leaving five ridges, the two lower ones being very faint, till finally they all become obsolete, leaving only the transverse lines. These are regularly arranged and very numerous, their distance apart in the adult shell being almost exactly 1 mm. From the appearance presented by one of the specimens it would seem that they imbricate, but this is not very distinctly seen. They form upon the peripheral area a very distinct and deep, backwardly directed sinus, indicating the presence of the hyponomic sinus of the aperture. On each side of the peripheral area there are three or four faint ridges in the young shell, but before the second whorl has been reached they have entirely disappeared. In a large individual in the senile stage of growth obscure folds and tubercles are developed upon the peripheral area and in one or two places upon its margin, but these are not sufficiently prominent to alter the general features of the shell.

The septation is not known, a cross-section of one of the specimens showing that it has been destroyed internally by mineral action; the presence of the test prevents the sutures from being seen externally, supposing them to have been preserved.

The siphuncle is about twice its own diameter from the peripheral margin (Pl. XXII, fig. 5 *c*).

The body-chamber is imperfect in the specimen in which it is seen (Pl. XXII, fig. 5 *a*). A very fine but distinct ridge runs along the median line of the peripheral area upon the cast of the body-chamber; no traces of this ridge are seen upon the test.

The test is rather thick, especially upon the umbilical border, where it forms

the thickened rim; here it is 4 mm. thick; below the rim, that is upon the umbilical declivity, it is 2 mm. thick; this thickness reaching about halfway to the line of inclusion of the preceding whorl, in which region it is reduced to 1·5 mm.

Affinities.—I am not acquainted with any species with which this may be strictly compared, though the young shell, in which the coarse and heavy rim of the umbilical border is undeveloped, is not unlike that of *Vestinautilus cariniferus*, J. de C. Sow., and was mistaken by me for that species until I had examined the specimen more closely and had seen the characteristic ornamentation of fine transverse lines. *Vestinautilus crassimarginatus* differs from *V. cariniferus* in having much more slowly increasing whorls, and in the presence of the very strong and coarse rim bordering the umbilicus, besides the fine and regular transverse striæ covering the whole of the test.

Remarks.—The question of the generic affinities of this shell is a difficult one to settle in the absence of a sufficient number of specimens wherewith to study the stages of growth from the very young to the old shell, and their modifications. The slow increase in the diameter of the whorls, their slight inclusion, and the great width of the umbilicus resulting from these two conditions, gives the shell, at first sight, a very different aspect from that of the more typical members of the genus to which I have referred it. Nevertheless, after careful study, I consider that these differences are outweighed by the resemblances, which consist of (1) the crater-like shape of the umbilicus, (2) the general form of the whorls, and (3) the non-tuberculated umbilical rim. It is unfortunate that the septation is not to be got at, as this would have aided very much in the determination of the affinities of the fossil.

Dimensions.—The largest specimen measures 127 mm. in its greatest diameter, and 102 mm. in its smallest. The specimen is thus elliptic: and that this form is the result of distortion by rock pressure is proved (1) by the asymmetry of the whorls both inner and outer, which do not follow the same spiral throughout their course, and (2) by the fact that in a young specimen there is no asymmetry at all. The height of the whorls relative to their width is as follows:—height, from centre of area of inclusion to centre of ventral area, 24 mm.; width, from the summit of one umbilical rim to the summit of the other, 44 mm.; thus the ratio of height to width is as 6 : 11.

I am indebted to the kindness of Prof. Grenville Cole for the loan of a specimen (the young one mentioned above) contained in the museum of the Royal College of Science for Ireland, Dublin, and from the same locality as the two full-grown specimens.

Locality.—Little Island, near Cork.

VESTINAUTILUS CARINIFERUS, *J. de C. Sowerby*, sp. Plates XXIII, figs. 1—3; XXVIII, figs. 2 *a*, *b*.

1825. NAUTILUS CARINIFERUS, *J. de C. Sowerby*. Min. Conch., vol. v, p. 130, pl. cccclxxxii, fig. 3 (excl. fig. 4).

? 1825. — BIANGULATUS, *J. de C. Sowerby*. Min. Conch., vol. v, p. 84, pl. cccclviii, fig. 2 (two figs.).

1828. — EXCAVATUS, *Fleming*. History of British Animals, p. 231.

1836. — CARINIFERUS, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 232, pl. xvii, fig. 19.

1836. — SULCIFERUS, *J. Phillips*. Ibid., p. 232.

1844. — (TEMNOCHEILUS) CARINIFERUS, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 20.

1855. — CARINIFERUS, *F. M'Coy*. British Palæozoic Fossils, fasc. 3, p. 557.

1889. CŒLONAUTILUS CARINIFERUS, *A. H. Foord and G. C. Crick*. Geol. Mag., dec. 3, vol. vi, p. 494, figs. A to D.

1891. — — *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 2, p. 112, fig. 15 A to D.

1893. VESTINAUTILUS CARINIFERUS, *A. Hyatt*. Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 420.

[*Not* 1844. NAUTILUS CARINIFERUS, *L. G. de Koninck*. Descrip. Anim. Foss. Terr. Carb. Belgique, p. 549, pl. xlviii, figs. 11, 12; 1878, Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, tom. ii), pt. 1, p. 134, pl. xxviii, figs. 1—5.

Description.—Shell thick-discoid, subglobose, subhexagonal in transverse section, the whorls all exposed in a large, funnel-shaped umbilicus, which has a small central vacuity. The umbilicus is bordered in the young and adolescent stages of growth by a prominent rim or keel, which becomes gradually obsolete on the body-chamber of the adult shell. The whorls overlap so as to conceal the rim, excepting for the last half-whorl; in approaching the edge of the aperture, where the whorl narrows a little, the rim is again completely exposed (Pl. XXIII, fig. 1 *a*). The periphery of the adult shell, seen in profile, rises into a low arch which is slightly depressed in the centre; while on each side one or two faint, obtuse ridges or keels appear, and from these the periphery abruptly descends on each side to the keels bordering the umbilicus.

In the young shell very strong and prominent ventral ridges are developed, and persist for the first three whorls, when they begin to become weak and fade into

the obscure ridges just described in the adult shell. These prominent ridges probably aided materially in giving firmness to the young shell, which as it became stronger absorbed them (Pl. XXIII, fig. 3).

The earlier whorls (about three of them) are distinctly inflated on the umbilical declivities, but as the shell advances towards the adult stage they become flattened and even concave in the lower half near the aperture.

The shell increases somewhat rapidly in diameter, the great lateral expansion giving rise to the deep, broadly funnel-shaped umbilicus.[1] The body-chamber occupies about half a volution; a little above its base are seen, in well-preserved casts, the impressions, consisting of pittings and other rugosities appertaining to the shell-muscle. These are admirably shown in a specimen from Cork in the collection of the British Museum (Natural History). They are figured in the 'Catalogue of the Fossil Cephalopoda,' British Museum, pt. ii, 1891, p. 106, fig. 15, where a full description of these remarkable impressions will be found. Other marks (Runzelschicht) originating in the soft parts of the animal are the singular rows of minute punctures, not unfrequently met with on casts of the body-chamber; these have a linear arrangement conforming precisely with the outline of the aperture, and are remarkably regular. The surface of the test is perfectly smooth, only fine striæ of growth being seen when it is suitably preserved.[2]

The septa are very numerous; upon the umbilical declivities the sutures are arched slightly backwards, and form in crossing the periphery a shallow, backwardly directed sinus; they increase slowly in their distance apart. Where the periphery measures 30 mm. in width they are 5 mm. apart, and this distance is increased to 8 mm. where the periphery is 45 mm. wide (Pl. XXIII, fig. 2).

The siphuncle is situated a little above the centre of the septum in the adult shell, but its position probably varies somewhat in the course of shell-growth.

The surface of the specimens that I have examined, and they are many, exhibit no markings except what may be described as lines of growth; but, as I have remarked in the description of *V. paucicarinatus*, this negative evidence must not be taken as conclusive, because mineral action in these fossils, though leaving a smooth and apparently uninjured surface, may have, as in the instance referred to, completely destroyed all surface markings not coarse enough to withstand it.

[1] The gigantic individual, whose dimensions are given on the next page, was presented to the Museum of Science and Art, Dublin, by Mr. Thomas Plunkett, M.R.I.A., of Enniskillen, an ardent geologist and archæologist.

[2] A specimen, apparently belonging to this species, from Glenbane, county of Limerick, shows two strong and prominent folds near the aperture on each side. Through an oversight, this specimen has not been figured in its proper place. It is figured in Pl. XXVIII.

Dimensions.

	Specimen from Clane of ordinary size.	Large specimen from Enniskillen.
Diameter of shell . . .	93 mm.	190 mm.
Height of outer whorl . . .	33 ,,	66 ,,
Diameter of penultimate whorl from suture to suture	35 ,,	95 ,,

Affinities.—Attention is drawn under the description of *Vestinautilus crateriformis* to the resemblances between that species and the present one, which therefore need not be here recapitulated. Another allied form is *V. paucicarinatus*, the ventral and lateral ridges in which are a distinguishing mark separating it readily from the present species, which except in the young shell (and according to Hyatt [1] in the adolescent also) are not developed or very feebly so. There is never any lateral or umbilical ridge or keel in *V. cariniferus*.

Remarks.—This species belongs to the group of crateriform and keeled shells which Professor Hyatt has marked off from *Cœlonautilus* and assigned to de Ryckholt's genus *Vestinautilus*,[2] a change which I have accepted.

The present species appears to be one of the most abundant as well as widespread in the Carboniferous limestone of Ireland. It seems to be much less common in England.

Localities.—Clane, county of Kildare; near Enniskillen, county of Fermanagh (the largest specimen known); Little Island, near Cork; Rathkeale and Ardtomin, county of Limerick.

VESTINAUTILUS CARINIFERUS, *J. de C. Sowerby*, sp. Var. *magnicameratus*, nov. Plate XXI, fig. 8.

The presence of a species or variety closely allied to *Vestinautilus cariniferus* has often suggested itself to me when looking over any large series of specimens assumed to belong to this species.

I have before me a specimen which, if the septa were not exposed to view, might easily be mistaken for Sowerby's species; their wide separation, however, is a feature which cannot be overlooked, and one which entitles this form to at least varietal rank. I therefore propose for it the name *magnicameratus* as expressing its chief characteristic.

[1] "Carboniferous Cephalopods." Second paper. 'Geological Survey of Texas, Fourth Annual Report,' 1892, p. 420.

[2] 'Notice sur les genres Nautilus, Vestinautilus, &c.,' de Ryckholt, 1852.

The specimen before me is much distorted, and part of the body-chamber is wanting. The umbilicus on one side is partly clear of the matrix, so that it reveals a portion of the penultimate whorl. Only part of the test is present, but there is sufficient to show that the keel bordering the umbilicus is not well defined, and that it becomes obsolete on reaching the body-chamber, the shell becoming more and more broadly rounded on the umbilical margin as the region of the aperture is approached. The outlines of the sutures of the septa are irregular owing to the crushing the shell has been subjected to, but it can be seen that they formed a shallow sinus in the median line of the periphery. The distance of the septa from each other in the latter position is 10 mm., close to the base of the body-chamber; the fourth and fifth, counting from the latter, measuring 9 mm., the seventh and eighth 7·5 mm. (cf. *V. cariniferus*, Pl. XXIII, fig. 2).

Dimensions.

	Specimen in Museum of Science and Art, Dublin.
Diameter of shell (approximate) . . .	73 mm.
Width of umbilicus, about	52 ,,
,, periphery	52 ,,
Height of outer whorl	32 ,,

Locality.—Limerick (? near the city).

VESTINAUTILUS CRATERIFORMIS, sp. nov. Plate XXIII, figs. 4 *a*—*c*.

Shell thick-discoid, subglobose, transversely subquadrate in section, the whorls all exposed in a deep, broadly crateriform umbilicus having a small central vacuity. The margin of the umbilicus, which is very acute in the cast, was, judging by a remnant of the test, apparently slightly keeled. The whorls overlap to the edge of the umbilical margin of the preceding whorls, leaving only an incised line to mark the place of this margin on the steep crater-like side of the umbilicus. The umbilical slopes are somewhat inflated, as in *V. cariniferus*. The peripheral area presents a low and broad arch which slopes a little more abruptly near the umbilical margin; faint traces of keels, one on each side of the latter, are seen upon the well-preserved fragment of the test still remaining; these keels are perceptible also upon the cast.

The body-chamber is imperfect, and is only a cast with fragments of the test adhering. On separating it from the septate part of the shell the position of the siphuncle is seen to be a little above the centre of the septum. The septa, the sutures of which are clearly exposed on the cast, are somewhat shallow; the

sutures form upon the umbilical slopes a series of curves, with the concavities directed forwards. Upon the peripheral area they sweep from side to side in a broad and shallow backwardly directed sinus. Their distance apart is very slowly augmented; where the transverse diameter of the peripheral area measures 30 mm. they are 7 mm. apart, this distance being increased to 10 mm. where the diameter is 45 mm. It will thus be noticed that they are wider apart than those of *V. cariniferus*, the form most nearly allied to the present one. There is a well-marked annular lobe (Pl. XXIII, fig. 4 *c*).

The surface of the test is seen, even where it is somewhat eroded, to be covered with fine, rather regular, transverse striæ of growth, and on the portion of the test preserved on the peripheral area, numerous faint, longitudinal striæ are visible, with here and there a backwardly directed sinus marking the form of this part of the aperture.

Affinities.—This species is very closely allied to *V. cariniferus*, J. de C. Sow., the differences separating the two forms being the following : the peripheral area is flatter and also broader than in *V. cariniferus*, the latter feature causing the sides of the umbilicus to be steeper than in that species. The septa, as has been shown, are wider apart in the present species than they are in Sowerby's ; hence it seemed justifiable to give the former a distinct name.

Remarks.—I am only acquainted at present with one specimen of this species, but its characters are well marked, and its recognition will thus be readily secured should other individuals be found.

Locality.—Rathkeale, county of Limerick.

Vestinautilus paucicarinatus, *A. H. Foord.* Plate XXIV, figs. 1—5.

1825. Nautilus multicarinatus, *J. de C. Sowerby.* Min. Conch., vol. v, p. 129, pl. cccclxxxii, fig. 2 (excl. fig. 1).

1878. — cariniferus, *L. G. de Koninck.* Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, Paléont., tom. ii), pt. 1, p. 134, pl. xxviii, figs. 1—5 (*not* of J. de C. Sowerby).

1891. Cœlonautilus paucicarinatus, *A. H. Foord.* Cat. Foss. Ceph. British Museum, pt. 2, p. 116, fig. 17.

1893. Vestinautilus paucicarinatus, *A. Hyatt.* Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 420.

Description.—Shell thick-discoid, composed of three volutions which increase rapidly in diameter and are exposed in a deep, funnel-shaped umbilicus, having a

small central vacuity. The whorl is trapezoidal in transverse section; in a more detailed view it is seen to be decagonal,—that is, it is made up of ten surfaces and angles. The peripheral area is broadly arched in general outline, but it presents, when more closely examined, three zones, the centre of which may be slightly concave; this is bordered by the two lateral zones, which descend rapidly to the umbilical margin. The umbilical declivity is again divided into two tolerably distinct areas (at least until the aperture is nearly reached); the upper, which is much the narrower, being the space marked off by the inner and outer keels of the shell; the lower comprising the space between the inner keel and the line of junction of the whorls. The remaining area is the impressed zone which, in the present species, is divided into three rather obscurely defined zones corresponding with those of the peripheral area which it embraces in the young shell. The overlapping or inclusion of the whorls extends to the umbilical marginal keel in the young shell, but in the adult it sometimes, though not always, leaves this keel free for the last half-whorl. The umbilical slopes are very slightly inflated below the inner keel; the whorl in the proximity of the body-chamber becoming also distinctly rounded on the umbilical shoulders, owing to the dying off of the keels bordering and just inside the umbilicus. The principal keels are those here referred to, the marginal one being the strongest, and resembling, in every respect, the one occupying the same position in *V. cariniferus*. It borders the umbilicus, which it completely encircles, dying off gradually as the body-chamber is reached. The inner keel is much less prominent than the outer one, to which it is approximate and parallel; it generally extends to within a very short distance from the aperture. The peripheral are generally much less conspicuous and prominent than the umbilical keels, and in some species they almost entirely disappear in the adult shell. Typically there are three on each side of the more or less flattened central zone of the peripheral area, the inner one being much less distinct than the outer ones. In the specimen figured (Pl. XXIV, fig. 1 *b*) these ventral keels are remarkably well developed. They are, in general, equidistant, the distance of the outer one from the umbilical keel being slightly greater than that separating them from each other. They are generally to be seen faintly on casts (Pl. XXIV, fig. 2).

The septa in this species are approximate, their distance from each other varying from 6·5 mm. to 8·5 mm. measured on a cast in the median line of the peripheral area (Pl. XXIV, fig. 2), the width of which is here from 50 mm. to 55 mm. The sutures have a curvature on the umbilical slopes of which the concavity is directed anteriorly. On the peripheral area they make the figure of a bent bow, the principal curvature of which has its concavity or sinus directed towards the aperture, as is always the case. There is an annular lobe (Little Island specimen).

The siphuncle, as seen in a polished section (Pl. XXIV, fig. 3) and in a distorted specimen from Little Island, is situated about its own diameter above the centre, its position remaining tolerably constant throughout the entire growth of the shell.

The surface of the test has hitherto been described as smooth, but a specimen from St. Doulagh's, in which the test is in a remarkably perfect state of preservation, shows a series of fine but very distinct longitudinal striæ covering it (cf. de Kon., 'Calc. Carb.,' pl. xxviii, fig. 3 *d*). These are indistinctly seen on another specimen with the aid of a lens; they would probably have escaped my observation had not their presence in the first-named specimen led me to make a careful search on others for similar markings. Crossing the keels bordering and within the umbilicus there is, at regular intervals, a series of minute but very distinct crenulations caused by a thickening of the lines of growth.

The perfect smoothness of the surface of the test—that is, the total absence of any markings, even of the most minute description—in most of these fossils is probably due to mineral action, which, in the slow process of fossilisation, completely replaced the original substance of the shell by calcite or by some form of that mineral (perhaps aragonite), obliterating all but the coarser markings. That this was not always the case, however, we see proofs in the presence of the minute surface markings described above, as well as under *Vestinautilus pinguis*.

In addition to these striæ there are transverse ones which are to be regarded as lines of growth, as they follow the contour of the whorls, and form upon the peripheral area the deep, backward bend which indicates the presence of the hyponomic sinus at the aperture. These lines are sometimes, though extremely fine, remarkably regular, so as almost to raise them to the rank of ornamentation; they become very crowded close to the aperture; before this point is attained about eight may be counted in the space occupied by 6 mm.

Affinities.—The general resemblance of this shell to *V. cariniferus* is sufficiently obvious and has already been dwelt upon; it differs from it chiefly in the presence of the inner keel of the umbilicus, in its wider septation, in having three more or less distinct keels on the peripheral area, and, perhaps may be added, the fine longitudinal striation recently observed, a feature, however, which *V. cariniferus* may yet be discovered to possess.

Remarks.—This is a very common species both in the Dublin district, with which I am best acquainted, and, apparently, in other parts of Ireland. De Koninck refers to it (under the name of *Nautilus cariniferus*) as being tolerably abundant at Pauquys, Dréhance, and Anseremme, in Belgium.

Localities.—St. Doulagh's, county of Dublin (common); Clane, county of

Kildare; Cork (near the city, but exact locality unknown; probably Blackrock); Little Island, near Cork.

VESTINAUTILUS PINGUIS, *L. G. de Koninck*, sp. Plate XXV, figs. 3 *a*, *b*.

1844. NAUTILUS PINGUIS, *L. G. de Koninck*. Descrip. Anim. Foss. Terr. Carb. Belgique, p. 551, pl. xlviii, fig. 10 (*not* of M'Coy).

1878. — — *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, tom. ii), pt. 1, p. 136, pl. xxx, figs. 6, 7.

1891. CŒLONAUTILUS PINGUIS, *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 2, p. 117, fig. 18.

1893. VESTINAUTILUS PINGUIS, *A. Hyatt*. Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 420.

Description.—Shell thick-discoid, composed of about three slightly embracing volutions, the sides of which are exposed in a deep, funnel-shaped umbilicus, with a central vacuity of moderate size. The whorls increase somewhat rapidly in their dimensions, their section in the adult is trapezoidal and decagonal. The periphery is very broad, and, compared with the height of the whorls, dorso-ventrally, as 22 : 37; it is divided into three areas, the median one the broader, two narrower areas on each side of it descending abruptly to the umbilical margin; the median area may be slightly depressed in the centre. The lateral area is represented only by a narrow zone, sloping inwards a little, bounded above by the keel bordering the umbilicus, and below by the second keel within the latter. The umbilical declivities are inflated considerably both in the young and in the adult shell.

The body-chamber occupies about one half of the last whorl.

The septa are moderately distant; thus, where the width of the peripheral area is 40 mm. they are 10 mm. apart, where the width is 31 mm. they are 7 mm. apart. Their course is tortuous; beginning at the suture-line of the penultimate whorl, they are bent slightly backward, and again upon the lateral zone; then, in crossing the periphery upon the area sloping upwards to the median zone, they arch forwards, making a broad, backwardly directed sinus on the median zone itself.

The siphuncle is not seen in the Irish specimens that have come under my notice, but de Koninck describes its position as being within the upper third of the septa.

The ornamentation is very conspicuous. It consists of prominent keels strong enough to leave their impression distinctly upon the cast. The first whorl, for

about half its length, has fine longitudinal ridges, one of which is continuous and forms the inner keel of the umbilicus. At the commencement of the second whorl the periphery bears on each side of the median area two keels, which gradually become obsolete, sometimes near the base of the body-chamber, where they may be represented merely by faint, slightly raised lines, sometimes extending nearer to the aperture. The periphery, losing the keels, here becomes rounded at the umbilical angles.

The two keels encircling the whorls are finely crenulated, at least up to the termination of the first whorl, and often as far as the extremity of the second, after which the crenulations disappear and the keels become simple.

The test, when suitably preserved, is seen to be covered with fine transverse lines of growth; of these lines, stronger ones occur at regular intervals and develop slight nodes in crossing the umbilical keels, thus giving rise to the beautiful crenulations just described. These crenulations do not appear to be developed upon the peripheral keels. Extremely fine lines, taking a longitudinal direction, cover the lines of growth; these are irregular and minutely tortuous in their course, and of silky fineness. They can be seen only with the aid of a lens.

The rarity of the preservation of such ornaments as these latter is probably due to the abrasion which the dead shell undergoes on the sea-bottom before being covered by the protecting mud. In some cases, perhaps in the majority of them, mineral or chemical action has probably operated in the obliteration of such delicate markings, when the deposit in which the fossils were entombed had become consolidated into rock.

Affinities.—The close resemblance between this species and *V. paucicarinatus*, Foord, is obvious upon comparing the figures of them (Pl. XXIV, and Pl. XXV, figs. 3 *a*, *b*); it would be scarcely possible to distinguish between them without the septa being exposed to view.

On comparing the septation of the present species with that of *V. paucicarinatus*, it is found that it is much closer in the latter species, in which the septa vary from 6·5 mm. to 8·5 mm., where the width of the peripheral area is from 50 mm. to 55 mm. It has just been stated that the septa in *V. pinguis* are 10 mm. apart where the width of the peripheral area is 40 mm. There is thus a very great difference in this respect between the two species.

Another feature in which *V. pinguis* differs from *V. paucicarinatus* is in the absence of the annular lobe conspicuous in the last-named species (cf. de Kon., 'Calc. Carb.,' *loc. cit.*, pl. xxviii, figs. 5 *a*, *b*; pl. xxx, fig. 6 *c*).

Remarks.—I have seen very few specimens of this species which could be identified as such, but, as I have already indicated, the presence of the test would render its identification difficult, if not impracticable; therefore some specimens

may have been passed over or mistaken for *V. paucicarinatus*, with which it is found associated.

Locality.—Limerick (probably near the city).

Vestinautilus semiplicatus, sp. nov. Plate XXV, figs. 1 *a*, *b*, 2 *a*, *b*.

Description.—Shell thick-discoid, of a robust habit, consisting of about four volutions, all exposed in a deep umbilical cavity having very steep sides. The whorls increase rather slowly in diameter, and their section is roughly decagonal; the peripheral area being more raised in the centre than at the sides, thus forming an irregular arch. The edge of the umbilicus is angular in the specimen before me (the only one known to me), and there is no rim or keel properly so called; a prominent one, however, is present within the umbilicus at a very slightly lower level than the margin of the latter, and hence forming a sort of platform, from the inner edge of which there is a steep slope down to the suture of the preceding whorl. Beginning at about the last half of the last volution the angularity of the whorl disappears, and at the same time the keel at the umbilical shoulders becomes plain and rounded. Just at the commencement of the body-chamber, on either side two large folds make their appearance; these are succeeded by another rather stronger pair, and these again (on the cast) by a pair of prominent tubercular folds which formed the outer boundaries of a former aperture, the hyponomic sinus of which is indistinctly seen on the cast in continuation of these folds. Two other pairs of prominent tubercular folds occur, the last of which formed the edge of the present aperture of the shell, the margin of which can be traced in the cast with its broad and deep hyponomic sinus. The body-chamber does not exceed half the length of the last volution. The septa and siphuncle are not known, as the test completely covers the septate part of the shell. There are no surface ornaments, but lines of growth which mark the form of the hyponomic sinus, already described, are seen at different places on the peripheral area; and, conforming in direction with these lines, there are also coarse and inconspicuous folds. Two faint ridges appear on each side of the peripheral area at its narrowest part; these were probably stronger in the young shell.

Dimensions.

	Unique specimen, from Rathkeale.
Diameter of shell	115 mm.
,, umbilicus (from edge to edge) . .	80 ,,
,, ,, (from suture to suture) .	45 ,,
Height of outer whorl (dorso-ventral) . .	47 ,,
Thickness at umbilical margin . . .	70 ,,
Width of periphery of outer whorl . . .	67 ,,

Affinities.—These are to all appearance with *V. paucicarinatus*, but in the absence of the septa they cannot be very well discussed. There are, however, very decided differences between the two species, firstly, in the dimensions of the peripheral area, which is much narrower in the present species than in *V. paucicarinatus*, and again in the height of the whorl, less dorso-ventrally in the former species than in the latter, these features resulting in a much shallower umbilicus; secondly, in the character of the area formed by the umbilical margin and the inner keel of the latter, as already described (cf. Pl. XXIV, figs. 1 *a*, *b*). The young individual figured upon Pl. XXV (figs. 2 *a*, *b*) has some points of resemblance with *V. semiplicatus* which cannot be overlooked; these are principally in the umbilical characters. Each has the shelf-like level area included in the space between the edges of the umbilicus strongly keeled in the young shell (cf. fig. 2 *a*) and the inner keel. No comparison can be made of the features presented by the peripheral area, as this is seen only in the senile stage of growth in *V. semiplicatus*. They are very strongly marked in the young individual, consisting of two deep and conspicuous sulci bordering the central zone, flanked upon the outside by two keels or ridges, the inner one, or that bordering the sulcus, being much stronger than the outer one. The central zone, which is slightly concave, is ridged on each side, the ridges, which are but slightly raised, forming the inner boundary of the sulcus on each side. Judging from numerous specimens of adult shells of *Vestinautilus*, it is probable that these conspicuous ridges and sulci do not persist, but that they become gradually obsolete as the shell progresses towards the adult stage.

Remarks.—The conspicuous tubercular folds upon the body-chamber of the present species would appear to be a senile character, the shell described showing signs in the coarse and rugose appearance of its surface that it has reached an advanced stage of growth. From the fact that only one specimen of this species has been obtained up to the present time it must not be too readily assumed that it is a rare one. The search on the occasion upon which the individual here described was obtained was too limited to justify any such conclusion. This part of the country has not had such attention bestowed upon it as the very interesting nature of some of the material already collected there ought to arouse. I hope something may be done before long to work up the fossil fauna of these rich south-western counties. The chief obstacle is the want of any local interest in the subject.

Locality.—Rathkeale, near Limerick.

VESTINAUTILUS MULTICARINATUS, *J. de C. Sowerby*, sp. Plate XXV, figs. 4 *a*, *b*, 5.

1825. NAUTILUS MULTICARINATUS, *J. de C. Sowerby*. Min. Conch., vol. v, p. 129, pl. cccclxxxii, fig. 1 (excl. fig. 2).

1836. — — *J. Phillips*. Geology of Yorkshire, pt. 2, p. 232.

1843. — — *J. E. Portlock*. Geology of Londonderry, p. 405.

1844. — (TEMNOCHEILUS) PORCATUS, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 22, pl. iii, fig. 6.

1860. TEMNOCHEILUS MULTICARINATUS, *R. Griffith*. Journ. Geol. Soc. Dublin, vol. ix, p. 57.

1878. NAUTILUS MULTICARINATUS, *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, Paléont., tom. ii), pt. 1, p. 121, pl. xxv, figs. 2 *a*—*c*.

1891. CŒLONAUTILUS MULTICARINATUS, *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 2, p. 114, fig. 16.

1893. VESTINAUTILUS MULTICARINATUS, *A. Hyatt*. Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 420.

Description.—Shell thick-discoid, composed of two and a half or three volutions, the sides of which are completely exposed in a deep, funnel-shaped umbilicus having a small, central vacuity. The whorls increase rapidly in diameter, the peripheral area projecting laterally and thereby greatly overhanging the dorsal or antiperipheral area. The zone of impression is distinct, its boundaries being those of the periphery. The section is subhexagonal in outline, the sides being represented by a very narrow zone bounded by strong keels. The periphery is broadly and tolerably evenly rounded, and is divided in all stages of growth into two distinct elevations by a narrow, median furrow; these elevations are highest on each side of and near to the furrow, from whence they slope abruptly down to the umbilical margin. Here the narrow zone, referred to above, occurs, and from this the steep declivities of the umbilicus, slightly inflated in their lower third, fall to the edge of the suture of the shell. It is to be observed that the lateral or narrow zone, as I have called it, is proportionately wider in the young and adolescent stages (*i. e.* in individuals measuring respectively 20 mm. and 45 mm. in diameter) than in the adult (?) shell (75 mm. in diameter).[1]

[1] It is not absolutely certain that the individuals of this species known up to the present time are in the adult stage of their growth, or that there may not be found much larger individuals than

The apical part of the initial whorl, exposed in a young individual by breaking away the enveloping whorl, has a very slight curvature, the succeeding volution completely covering its peripheral area. It is depressed dorso-ventrally like the adult shell, which it resembles in miniature; it expands rapidly; the apex is scarcely 1 mm. in its lateral diameter; at a distance of 7 mm. this has increased to 3·5 mm. The lateral areas are circumscribed, as in the adult shell, by two ridges which are much more prominent than the others; the dorsal area is evenly and gently rounded, its surface is ornamented with nine or ten fine but distinct ridges, which are crossed by minute lines of growth. The ridges do not cover the extreme apex, which is apparently smooth (Pl. XXV, fig. 5). They increase rapidly in strength and prominence as they advance from the apex.

The septa in this species are very numerous; the sutures are 5·5 mm. apart upon the periphery, where the width of the latter is 30 mm. Their course conforms in its direction to the shape of the periphery; upon the two elevations they curve gently forwards and form a backwardly directed, shallow sinus in crossing the median furrow. Upon the narrow lateral zones they curve slightly backwards, taking the same direction on the umbilical declivities.

The siphuncle is a little below the centre of the septum.

The ornamentation, remarkably well developed in this species, consists of strong, prominent, rounded, longitudinal ridges or keels covering the peripheral area and bordering the lateral zones, but obsolete upon the umbilical declivities. Five of these ridges occupy the elevated areas on each side of the median furrow on the periphery; the outermost of them forms the upper boundary of the very narrow lateral zone, the lower boundary of which is constituted by the ridge which forms the edge of the umbilicus. A ridge, much less prominent than any of the others, occurs near the summit of the umbilical declivity just beneath the keel bordering the latter. This supplementary ridge is present in all stages of the growth of the shell, beginning with the initial innermost whorl. Though resulting from a vertical thickening of the test, the ridges nevertheless leave distinct elevations upon the cast. They are divided upon the periphery by spaces of about their own width, but a slightly greater space separates the outermost keel from the one bordering the umbilicus, this space being what I have called the lateral zone, whose plane is at right angles to that of the periphery. The

any that have yet been described, as has proved to be the case with *Vestinautilus cariniferus* (see above, p. 84). Signs of the adult stage are generally to be discerned in some modification of the ornaments of the test, which on the one hand may become coarser, or on the other obsolete or nearly so; the latter condition usually indicating the senile, or, to use Professor Hyatt's expression in its broader sense, gerontic stage. It must be observed that these signs of maturity are not present in the individual whose diameter I have given above, which is, moreover, broken anteriorly; hence the query.

outermost keel of the periphery is always thicker than any of the others, and this in all stages of growth of the shell.

The surface of the test is covered with fine transverse lines of growth, broadly sinuous on the periphery.

Affinities.—The present species most nearly resembles *Vestinautilus pauci-carinatus*, A. H. Foord, from which it differs in its numerous keels and in its very narrow lateral zone. From *V. pinguis*, L. G. de Koninck, it is distinguished by the first of these characters and by its much closer septa.

Remarks.—"The specimens belonging to this species in the British Museum Collection prove conclusively that the number of keels does not depend upon the age of the shell, as supposed by Sowerby ('Min. Conch.,' loc. cit.), and that the latter included under the name *multicarinatus* two distinct types."[1] One of these, viz. that having the richly keeled peripheral area, was chosen by de Koninck (loc. cit.) as the type of *multicarinatus;* to the other I gave the name *pauci-carinatus*.[2]

The fragment now before me, described by M'Coy under the name of *Nautilus* (*Temnocheilus*) *porcatus*, has long been recognised as belonging to the present species. Both d'Orbigny[3] and Giebel[4] make this observation, though they neither of them noticed that Sowerby had blended two distinct forms under one name.

The fragment in question is a cast of a portion of the body-chamber of a small individual. The specimen measures 30 mm. in length and 20 mm. in its greatest breadth. The characteristic ridges and median furrow are well preserved, and leave no doubt as to the identity of the fossil, which was obtained in the Carboniferous shale at Townparks, Killeshandra, county of Cavan. It is in the "Griffith Collection" of the Science and Art Museum, Dublin.

Finally, Phillips[5] recorded a species under the name *multicarinatus*, Sow., from Cork and Cumberland, possessing many ridges and furrows, which may also be referred, without much hesitation, to the present species.

Localities.—Kildare, Cork (the counties only can be given); Townparks, Killeshandra, county of Cavan.

[1] 'Cat. Foss. Ceph. British Museum,' pt. 2, 1891, p. 115.

[2] Loc. cit., p. 116.

[3] 'Prodrome de Paléontologie Stratigraphique.' vol. i, p. 110.

[4] 'Fauna der Vorwelt,' Band iii, Abth. 1, p. 174.

[5] Loc. cit.

Genus PLANETOCERAS, *Hyatt*, 1893.

PLANETOCERAS GLOBATUM, *J. de C. Sowerby*, sp. Plate XIX, figs. 5 *a*, *b*, 6.

1821. NAUTILUS GLOBATUS, *J. de C. Sowerby*. Min. Conch., vol. v, p. 129, pl. ccccl xxxi.

1844. — (TEMNOCHEILUS) GLOBATUS, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 21.

1860. TEMNOCHEILUS GLOBATUS, *R. Griffith*. Journ. Geol. Soc. Dublin, vol. ix, p. 77.

1891. CŒLONAUTILUS GLOBATUS, *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 2, p. 127, fig. 20.

1893. PLANETOCERAS GLOBATUM, *A. Hyatt*. Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 421.

Description.—Shell subglobose, consisting of about two and a half volutions, the inner ones exposed in a very deep umbilicus with almost vertical sides and a central vacuity of moderate size. The shell increases rapidly. The apex is conical. The periphery is flattened in the young shell, and there is a distinct angle at the edge of the umbilical vacuity which persists to the completion of about one and a half volutions, where it develops into a strong keel which is slightly inflected, so that its edge faces the umbilicus. The periphery, flattened in the young shell, becomes rounded in the adolescent and adult stages, but it tends towards the aperture to be again somewhat depressed. The last whorl, by its lateral expansion and the depression of the peripheral area in approaching the aperture, assumes a laterally spreading form, with a very wide, dorso-ventrally contracted aperture.

Near the aperture the body-chamber frees itself from the penultimate whorl and arches upwards tangentially to the original coil.

The aperture has a somewhat broad hyponomic sinus, on each side of which two broadly rounded lobes or "crests" project. At the angles just below the keel there is a slight notch or wave in one of the specimens before me, but the line of the aperture connecting these points has not been seen.

The body-chamber occupies half of the last whorl.

The septa are rather approximate, their distance in a young shell being about one fifth of the dorso-ventral diameter.

The siphuncle is nearly central.

The surface of the test is smooth, only extremely fine lines of growth being seen when it is well preserved. In a young and almost complete specimen, in which the

test is in some places preserved in a state of perfection rarely seen in fossils, there are exceedingly delicate longitudinal, apparently incised lines crossing the lines of growth (Pl. XIX, fig. 5).

Dimensions.

	Adult individual (Mus. Science and Art, Dublin).	Young individual.
Diameter of shell (exclusive of free portion) . .	. 92 mm.	45 mm.
Height of outer whorl . .	. 45 ,,	20 ,,
Width of umbilicus . .	. 28 ,,	15 ,,

Affinities.—As I am acquainted with actual specimens of only one species—the one just described—I can say nothing under this head from personal knowledge. Professor Hyatt [1] describes a new species under the name of *Planetoceras retardatum*, which he compares with *P. globatum*. He says: "This (*P. retardatum*) has the same outline to the aperture as in *globatum*, and a similar living chamber, but is much smaller, and the whorls are not so stout or broad in proportion. The ephebic (adult or mature) stage has, however, been fully attained, as is shown by the rounded lateral zones of the whorls and the uncoiled character of the outer part of the living chamber."

I think I was in error in assigning *Nautilus atlantoideus*, de Koninck, to the present species,[2] and I accept Professor Hyatt's correction when he says that *N. atlantoideus* "differs too much in the development of the young, if figured correctly by de Koninck, to be considered identical with *P. globatum*." [3]

Remarks.—The remarkable laterally expanded and contracted form of the free portion of the body-chamber in this species differentiates it from all other Nautiloid shells of the Carboniferous rocks, the immature as well as the adult shell exhibiting these features in an almost equally marked degree.

This is a very common shell at St. Doulagh's, scarcely any series of fossils from the quarries there being without specimens of it.

Localities.—St. Doulagh's, county of Dublin; "Kildare" (probably Clane). Doneraile, county of Cork (*fide* Sir R. Griffith, in his list of localities appended to M'Coy's 'Synopsis,' 1862 issue).

[1] "Carboniferous Cephalopods." Second paper. 'Geological Survey of Texas, Fourth Annual Report,' 1892, p. 421.

[2] 'Cat. Foss. Ceph. British Museum,' pt. 2, 1891, p. 128.

[3] Loc. cit., p. 422.

Family Rineceratidæ.

Genus Thrincoceras, *Hyatt*, 1893.

Thrincoceras Hyatti, sp. nov. Plate XXVI, figs. 1 *a*—*g*.

Description.—Shell discoid, compressed, composed of nearly three whorls, the sides of which are entirely exposed in a shallow umbilicus having a small, central vacuity.

The whorls increase rather slowly in diameter, the last one in the adult shell becoming detached from the preceding one for a short distance. The body-chamber occupies about half a volution. The section is subquadrangular and hexagonal; the peripheral area is depressed but somewhat convex; the sides are flattened and converge from the umbilical angle towards the periphery. The umbilical slopes in the adult shell are moderately steep, the angle connecting them with the sides not distinctly defined. There is no distinction in the young shell between the sides and the umbilical slopes, the whorls being there evenly rounded. The peripheral area in the adult, on the other hand, is separated from the sides by a well-defined angle, but whether this is the case in the young shell I have no means of judging, as that part of the shell is covered up by the later volutions in the specimens available for study.

The impressed zone, which is shallow, is marked out by obscure, rounded elevations (Pl. XXVI, fig. 1 *c*). The presence of this zone indicates, in the young shell, a slight median elevation which is less distinct in the adult.

The septa are moderately distant; where the diameter of the whorl is 15 mm. they are 5 mm. apart upon the sides of the shell, and this distance scarcely varies in the entire whorl, the diameter of which is 63 mm. The sutures form a somewhat deep, backwardly directed lobe upon the sides, cross the umbilical margin with an acute angle, and form a rather shallow sinus upon the periphery.

The siphuncle, as seen in the young shell, is a little above the centre of the septum (Pl. XXVI, fig. 1 *g*).

The ornamentation of this species is very elaborate. The test is completely covered with fine, acute, longitudinal ridges; in the adult shell these are widest apart upon the umbilical declivities, where there are five or six upon the last whorl; on the sides they become closer, about twelve may here be counted; upon the periphery they are still finer, there being sixteen or seventeen, of which four or five are crowded together on each side of the median zone, where there are six more widely spaced ones. The ridges are developed also upon the impressed

zone. The interspaces are always wider than the ridges themselves, in some places twice as wide.

Between the ridges, where the test is well preserved, there are to be seen, with the aid of a magnifier, exceedingly fine longitudinal lines, of which three or four may generally be counted, but in some places only one is present; they persist throughout the adolescent and adult stages; I am not able to say positively whether they occur in the young also, but probably they do not, as the closeness of the ridges would scarcely leave room for their development (Pl. XXVI, figs. 1 *d*—*f*).

Fine lines of growth cover the whole surface of the test, causing slight nodular excrescences where they cross the ridges. These lines become more distinct in crossing the periphery, where they form a very deep sinus corresponding with that of the aperture (Pl. XXVI, fig. 1 *a*).

Dimensions.

	Adult specimen from St. Doulagh's, in the Museum of the Royal College of Science, Dublin.
Diameter of shell	90 mm.
,, umbilicus (from edge to edge)	43 ,,
,, ,, (from suture to suture)	35 ,,
Height of outer whorl (dorso-ventral)	28 ,,
Thickness at umbilical margin	30 ,,
Width of periphery of outer whorl	20 ,,

Affinities.—I point out on page 102 the relationship subsisting between *Thrincoceras Hibernicum* and the present species. As it was in studying *T. Hyatti* that I was first led to conclude that the genus *Thrincoceras* was represented in Ireland by these two species, it will naturally be supposed that *T. Hyatti* should show a marked resemblance to the American species described by Hyatt, which is, in fact, the case. Of the two species of *Thrincoceras* described by Hyatt,[1] that which he has named *Thrincoceras Kentuckiense* is the most strictly comparable with the present species. Neglecting the superior dimensions of the American form, which has a diameter of 170 mm. against 90 mm. in the largest Irish shell before me, the resemblances between the two are such as easily catch the eye, and, in spite of the very rough figures given in the 'Geology of Texas,' I was at once reminded of them when the fossil, here under description, came under my notice.

Professor Hyatt's specimens appear to have been poorly preserved, as is indicated in one of the figures he gives of *T. Kentuckiense*, which is a cast showing

[1] "Carboniferous Cephalopods." Second paper. 'Geological Survey of Texas,' 1893. Reprinted from Fourth Annual Report, 1892, pp. 430—434.

no vestige of the ornaments of the shell (loc. cit., figs. 11, 12). He describes the umbilical perforation in this species as "very large," though "the size could not be exactly ascertained, owing to the breaking out of part of the youngest whorl." In *T. Hyatti*, as indicated above, the central vacuity of the umbilicus is *small*. I observe, however, that in *T. Kentuckiense* the central vacuity is represented in one of the specimens figured (fig. 12) as very much smaller than in another (fig. 14). Thus fig. 12 represents a shell resembling *T. Hyatti*, in this respect, as closely as need be.

Professor Hyatt does not describe the ornamentation of *T Kentuckiense* in detail, but he refers to the figure of another species (*T. depressum*), the ornamentation of which is presumably essentially similar to that of the first-named species. In his description of *T. depressum* he says: "The larger ridges have fine longitudinal ridges between them, and in the later stages these become more prominent and visible to the naked eye. There are usually three or four of these between each pair of large ridges on the umbilical zone, where alone they were observed, the condition of the shell elsewhere not permitting them to be seen. Between each pair of these secondary ridges there appears, under the magnifier, a third series of single longitudinal lines. Sometimes these three kinds of ridges were all of the same size in the shell examined, so that it was difficult to decide whether they did not all belong to the same system. The longitudinal system of ridges are crossed by obscure striæ of growth visible only under a magnifier in this shell."

The ornamentation here described agrees perfectly with that of the present species, except that the interstitial ridges are more numerous in Hyatt's species than in the latter, a difference which may well be due to the much larger size of the Texan forms admitting of such additions. As regards the septation, the backwardly directed sinus upon the peripheral area in *T. Kentuckiense* is much deeper than in *T. Hyatti*. It may be here mentioned also that the outline of the periphery is more rounded in the former species than in the latter.

Remarks.—The most striking feature in the present species is the beautiful system of ridges which so completely covers, while it ornaments, the shell. By means of the sculpture the most imperfect specimens of this species may be recognised, its characteristic appearance appealing at once to the eye.

Locality.—St. Doulagh's, county of Dublin.

THRINCOCERAS HIBERNICUM, *A. H. Foord*, sp. Plate XXVI, figs. 2 *a*, *b*.

1891. GYROCERAS HIBERNICUM, *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 2, p. 64, fig. 5.

1893. RINECERAS HIBERNICUM, *A. Hyatt*. Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 425.

Description.—Shell discoid, composed of two and a half to three whorls, with a wide, rather shallow umbilicus, having apparently a large central vacuity. The section is subquadrangular and hexagonal; the periphery broad, compressed, very slightly convex; the sides flat, the umbilical declivities not very steep; their junction with the sides not well defined, but in the adolescent stage an obtuse angle is here formed, which becomes rounded off towards the aperture.

The whorls increase rather slowly in diameter; the last one near the aperture detaches itself for a very short distance from the penultimate whorl. The peripheral area only is concealed by the embracing whorls, the sides of the inner whorls being entirely exposed.

The body-chamber appears to extend to about half a volution; the outline of the aperture has not been seen.

The septa are numerous; there are about twenty-two in a complele volution in the young shell. They curve abruptly backwards upon the sides and periphery, forming an acute angle upon the edge of the latter. The last two septa are 5 mm. apart.

The siphuncle has not been seen.

The ornamentation consists of numerous acute, longitudinal ridges, of which there are nine or ten comparatively coarse ones upon the sides and umbilical declivities, and eleven finer ones upon the peripheral area. The ridges are finer and less prominent at the lower part of the umbilical declivity, near the suture of the shell, and become gradually stronger and more distinctly defined, as well as wider apart, until the edge of the periphery is reached, upon the surface of which they are very delicate, though preserving their distinctness.

The finer ornaments consist of a series of very fine transverse lines, which, thickening as they cross the ridges, give to the latter a strikingly crenulated character.

These lines cross the whorls with a slight backward deviation, but on the peripheral area they describe a very deep, backwardly-directed sinus, which indicates a hyponomic sinus at the aperture of similar form.

Dimensions.

	Specimen from Glenbane, Limerick.
Diameter of shell	64 mm.
,, umbilicus (from edge to edge)	40 ,,
,, ,, (from suture to suture)	30 ,,
Height of outer whorl (dorso-ventral)	16 ,,
Width of periphery of outer whorl	20 ,,

Affinities.—This species may be compared with *T. Hyatti*, but the resemblance between them is of a very general character, the differences that distinguish them being, on the other hand, very strongly marked. Looking first at the points of agreement, we find that, like *T. Hyatti*, *T. Hibernicum* is ornamented with longitudinal ridges which cover the whole of the shell, and that the general form of the latter is distinctly subquadrangular, with a flattened peripheral area and a somewhat obscurely defined separation between the sides and the umbilical declivities. The differences consist, firstly, in the presence of distinct crenulations formed at the intersection of the two systems of lines which ornament the shell in *T. Hibernicum* which are not present in *T. Hyatti;* secondly, the ornamentation is coarser in the former than in the latter, and it would seem, though my material does not admit of certainty on this point, that the central vacuity is larger in *T. Hibernicum* than in *T. Hyatti.*

Remarks.—Hyatt referred this species rather doubtfully to his genus *Rineceras*, but though the ornamentation may suggest affinities with the members of that genus, of which *R. propinquum*, de Koninck, is taken as the type, yet the form of the whorls and the close coiling indicate connection with another series of forms, and, after much deliberation, I have decided to include it in that of *Thrincoceras.*

Locality.—Glenbane, county of Limerick; near Dublin.[1]

Genus Discitoceras, *Hyatt*, 1883 (emend. 1893).

Discitoceras Leveilleanum, *L. G. de Koninck*, sp. Plate XXVII, figs. 1—3.

1844. Nautilus Leveilleanus, *L. G. de Koninck.* Descrip. Anim. Foss. Terr. Carb. Belgique, p. 552, pl. xlix, fig. 1 (pl. xxv, fig. 1 excl.).

1878. — — *L. G. de Koninck.* Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, Paléont., tom. ii), pt. 1, p. 143, pl. xxviii, fig. 6.

1891. Discites Leveilleanus, *A. H. Foord.* Cat. Foss. Ceph. British Museum, pt. 2, p. 88.

[1] British Museum specimen, "Catalogue," loc. cit.

1893. Discitoceras Leveilleanum, *A. Hyatt.* Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 435.

Description.—Shell discoid, somewhat compressed, rather slowly tapering, composed of about three and a half whorls having rounded angles, and all exposed in a wide and shallow umbilicus with a central vacuity of moderate size. The section of the whorls is of a modified hexagonal form, the angles of the whorls in the adult stage showing a tendency to become rounded, so that the distinction between the umbilical, lateral, and peripheral areas almost disappears. The apex is bluntly conical, and is covered to its extreme tip by the ornamentation of the test. In the young shell the whorls are more generally rounded than at a later stage—the adolescent—when they become angular at the umbilical margin, this angularity gradually becoming softened until it finally disappears in the region of the aperture. The latter has an open sigmoid curvature, with a moderately deep hyponomic sinus upon the periphery, where also the lines of growth become coarse and irregular.

The length of the body-chamber extends to about half a volution. The shell becomes detached from the penultimate volution in approaching the aperture (Pl. XXVII, figs. 1 *a*, 2 *a*).

The ornaments of the test are strikingly beautiful. They consist of a series of fine, acute, longitudinal ridges, which, very close-set in the young shell, gradually widen out as the whorls increase in diameter, ceasing abruptly at the end of about two and a half volutions. These ridges cover the sides of the shell, the peripheral area, and the umbilical declivity, extending sometimes along the latter in three or four widely separated ridges, considerably beyond the place where the lateral ones have become obsolete.

Fine, very close-set, and remarkably regular transverse lines of growth cover the whole surface of the test, giving rise to crenulations where they cross the longitudinal ridges. These lines of growth, becoming coarser in the more mature shell, are seen to be of the nature of narrow bands; when magnified, they vary greatly in width, sometimes two, sometimes even four, occupying the space of a millimetre. Their general texture, however (if the expression may be used), suggests uniformity to the eye when unaided by the lens. They are admirably shown in the larger figure of this species (Pl. XXVII, fig. 2 *a*).

Dimensions.	Large specimen from Clane, Museum of Science and Art, Dublin.
Diameter of shell	124 mm.
Height of outer whorl	45 ,,
Diameter of umbilicus (approximate)	70 ,,

Affinities.—*Discitoceras discors*, F. M'Coy (a doubtful species), bears a close resemblance to the present species, the ornamentation being exactly similar, the difference between them consisting solely in the form of the whorls, which are more or less rounded in *D. Leveilleanum*, subquadrate in *D. discors*.

On comparing the present species with *D. Wrightii*, it is seen that the latter has fewer whorls and a much smaller central vacuity, also that the ornamentation is finer and of a different character, the finely beaded ridges in *D. Wrightii* presenting a very different aspect from the ornament of *D. Leveilleanum*.

Localities.—Clane and Naas, county of Kildare.

? Discitoceras discors, *F. M'Coy*, sp. Plate XXVII, figs. 4 *a*—*e*.

1844. Nautilus (Discites) discors, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 17, pl. iii, fig. 5.
1860. — discors, *R. Griffith*. Journ. Geol. Soc. Dublin, vol. ix, p. 56.
1878. — — *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, tom. ii), pt. 1, p. 143, pl. xxx, figs. 8 *a*, *b*.
1883. Discitoceras discors, *A. Hyatt*. "Genera of Fossil Cephalopods," Proc. Boston Soc. Nat. Hist., vol. xxii, p. 292.
1891. Discites discors, *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 2, p. 90.
1893. — — *A. Hyatt*. Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 435.

Description.—Shell discoid, compressed, consisting of about three, or at the utmost three and a half volutions (not five, as stated by M'Coy), the sides of which are exposed in a large and shallow umbilicus with a central vacuity of moderate size. The section of the shell, in which lies its chief characteristic, is subquadrate, the periphery slightly convex, nearly as broad as the sides, which are flattened and distinctly angular at their edges, not rounded as in *Discitoceras Leveilleanum*.

The size of the body-chamber is stated by de Koninck (loc. cit.) to be about one-half of that of the last whorl. I have not seen it entire in any specimen.

The siphuncle is said by de Koninck to be situated in the upper third of the septa.

The septa are moderately distant, varying from 6·5 to 8 mm. apart, at about one-fourth of a whorl from the body-chamber, the last two being 5 mm. apart; their sutures are sharply bent back at the sides and form an acute lobe, anteriorly directed, upon the peripheral angles; upon the periphery they form a shallow sinus.

The ornamentation in this species is precisely similar to that of *Discitoceras Leveilleanum*, de Kon.

Affinities.—This species closely resembles *Discitoceras Leveilleanum*, de Kon., differing from it only in the form of the whorls, more or less rounded in de Koninck's species, subquadrate in M'Coy's.

Remarks.—I have much hesitation in regarding this species as valid. All the specimens I have seen (all from the Cork district—Cork or Blackrock, both in the county of Cork) are *compressed* in the dorso-ventral direction of the whorls, and rendered elliptical thereby, and all but one *distorted*. M'Coy's type has been lost; there is no specimen in the "Griffith Collection" (Dublin Museum of Science and Art), which ought to contain it, answering to his figure (loc. cit.), which shows an ornamentation, as I have said above, precisely similar to that of *Discitoceras Leveilleanum*. The specimen in the Griffith Collection is mainly a cast showing the septa, with fragments of the test, so badly preserved as to exhibit not the faintest trace of ornamentation.

When in Brussels in 1893 I made a careful study and a drawing of the specimen figured by de Koninck ('Calc. Carb.,' loc. cit.), and contained in the Museum of Natural History (Parc Léopold). His specimen is distorted in a similar manner to the Irish ones, thus strengthening the view to which I am now strongly inclined, that *D. discors* represents merely distorted or compressed individuals of *D. Leveilleanum*. If this be actually the case, the latter species would become the type of the genus, displacing the former which I proposed as the type when describing the species contained in the British Museum ('Cat. Foss. Ceph.,' 1891, pt. 2, p. 87).

M'Coy was evidently not acquainted with de Koninck's species *D. Leveilleanum*, for he could not have overlooked its obvious similarity to *D. discors*, the latter name suggesting the most salient feature in the ornamentation of de Koninck's species, viz. the discontinuance of the ridges in the adult volutions specially pointed out by M'Coy.

Localities.—Clane, and Naas (British Museum specimen), county of Kildare; Blackrock, county of Cork.

DISCITOCERAS WRIGHTII, sp. nov. Plate XXVI, figs. 3 *a*—*d*.

Description.—Shell discoid, rather compressed, with a somewhat planorbiform configuration. Whorls about three in number, rather slowly increasing in diameter, all being exposed in a shallow umbilicus with a small central vacuity.

The whorls are somewhat flattened at the sides, the periphery gently rounded. (Lateral pressure has altered the shape of the periphery in the specimens before

me, making the margin subangular on one side.) The umbilical declivities being rounded, there is no well-defined boundary between them and the sides into which they merge. The whorls come into contact only upon the peripheral area, and there is consequently no overlapping.

The length of the body-chamber cannot be given with exactness, but it appears to have occupied at least half a volution. The aperture has not been seen. The last whorl detaches itself from the penultimate one in approaching the aperture.

The septa, seen only on the sides of the shell (and there exposed by artificial means), are 5 mm. apart where the diameter of the whorl is 11 mm.; thus they are, relatively to this, wide apart. The interior of the chambers is filled with clear crystalline calcite, the deposit of which has nearly everywhere destroyed the septa in the specimens before me.

The siphuncle is considerably above the centre (Pl. XXVI, fig. 3 *c*).

The ornamentation consists of extremely fine longitudinal ridges, which, as in other members of this genus, become obsolete upon the second volution. Crossing the ridges is a series of equally fine transverse lines of growth, which at the point of intersection of the two systems of lines form little nodes, which impart a finely beaded appearance to the ornamentation viewed as a whole. The ornamentation is so fine as to require magnifying to bring it out clearly. Beyond its limits irregular lines of growth are developed, which in the adult shell are here and there rather strongly marked. Otherwise the shell may be regarded as quite smooth except in the first whorl and part of the second.

Dimensions.—Diameter of shell 90 mm.; width of umbilicus 47 mm.; height of outer whorl 25 mm. (Pl. XXVI, fig. 3 *b*).

Affinities.—From *Discitoceras Lecoilleanum*, de Kon., the present species is easily distinguished by the absence of the numerous and regular transverse lines invariably met with in the former, as well as by the much less prominent character of the longitudinal ridges, which, as stated above, present the finely beaded appearance, which is not the case in *D. Lecoilleanum*, in which the longitudinal ornaments, as far as they are developed, are much more conspicuous than the transverse ones. *D. Wrightii* would, in fact, at first sight be taken for a perfectly smooth shell, and it is not until the lens is brought into requisition that the fine ornaments of the inner whorls are revealed.

Remarks.—This species is quite common at Little Island, near Cork, but it is rarely obtained undistorted, having generally an elliptical form with the peripheral area pressed out of shape, making one side of the shell flatter than the other. An uncompressed specimen is, however, shown in Pl. XXVI, fig. 3 *a*. I have named this species after my friend Mr. Joseph Wright, F.G.S., of Belfast.

Localities.—Little Island and Midleton, near Cork.

DISCITOCERAS COSTELLATUM, *F. M'Coy*, sp. Plate XXVIII, figs. 4 *a*, *b*.

1844. NAUTILUS (DISCITES) COSTELLATUS, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 17, pl. ii, fig. 4 (three figures).

1883. DISCITOCERAS COSTELLATUM, *A. Hyatt*. Genera of Fossil Cephalopods, in Proceed. Boston Soc. Nat. Hist., vol. xxii, p. 292.

1891. DISCITES COSTELLATUS, *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 2, p. 87.

1893. DISCITOCERAS COSTELLATUM, *A. Hyatt*. Carboniferous Cephalopods. Second Paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 435.

Description.—Shell (fragment) discoid, consisting of portions of two of the inner whorls which are only in contact at the periphery; the section is broader than high, about in the ratio of 9 : 14. The umbilicus is deep and of moderate width. The periphery is broadly rounded, the sides are bluntly angular, sloping abruptly from the margin of the umbilicus to the point of contact of the preceding whorl. The dorsal or anteperipheral area has a slight curvature corresponding with the periphery of the whorl which it enfolds. The septa, as seen in a natural section, are rather deeply concave; their distance apart is not known. The siphuncle is central, or perhaps slightly above the centre in the young shell. The body-chamber is not known.

The ornamentation consists of about twenty-one fine longitudinal ridges, those on the sides of the shell being both coarser and wider apart than those on the periphery. The latter has a central ridge with three on either side of it closer together than the width separating them from the central ridge; a slightly greater space again occurring between the outer one of the three and the one of the coarser series which, to the number of four, occupy the area extending to the edge of the umbilicus. Within the latter only three can be seen in the specimen before me.

Extremely fine, close-set lines of growth, barely visible to the naked eye, cover the surface of the test, and show by their outline upon the periphery that the aperture possessed a very deeply excavated hyponomic sinus.

Affinities.—The character of its ornamentation would make this species easily recognisable, and it also distinguishes it from other species of *Discitoceras*, of which *D. Wrightii* is the nearest to it. The beaded ornamentation of the latter, however, differentiates it readily from *D. costellatum*.

Remarks.—The fragment now representing the present species in the "Griffith

Collection" may or may not be a portion of the specimen figured by M'Coy; if it be so it has lost more than half of its original bulk.

Locality.—Millicent, Clane, county of Kildare.

Genus—PHACOCERAS, *Hyatt*, 1883.

PHACOCERAS OXYSTOMUM, *Phillips*, sp. Plate XXVIII, figs. 3 *a*, *b*.

1836. NAUTILUS OXYSTOMUS, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 233, pl. xxii, figs. 35, 36. (Not of Trautschold, Nouv. Mém. Soc. Imp. Nat. Moscou, tom. xiii, p. 304, pl. xxx, fig. 7.)

1843. — — *L. G. de Koninck*. Descrip. Anim. Foss. Terr. Carb. Belgique, p. 544, pl. xlix, figs. 3 *a*, *b*.

1844. — (DISCITES) OXYSTOMUS, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 18.

1855. — OXYSTOMUS, *F. M'Coy*. British Palæozoic Foss., fasc. iii, p. 560.

1860. DISCITES OXYSTOMUS, *R. Griffith*. Journ. Geol. Soc. Dublin, vol. ix, p. 33.

1878. NAUTILUS OXYSTOMUS, *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, tom. ii), pt. 1, p. 123, pl. xvii, figs. 3 *a*, *b*.

1883. PHACOCERAS OXYSTOMUM, *A. Hyatt*. Genera of Fossil Cephalopods, Proceed. Boston Soc. Nat. Hist., vol. xxii, 1882–3, p. 293.

1891. DISCITES (PHACOCERAS) OXYSTOMUS, *A. H. Foord*. Cat. Foss. Ceph. Brit. Mus., pt. 2, p. 99, fig. 12 (about two-thirds nat. size).

1893. PHACOCERAS OXYSTOMUM, *A. Hyatt*. Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, pp. 438, 446.

Description.—"Lenticular, very much compressed laterally; greatest thickness at the edge of the small shallow umbilicus, from whence the sides slope, almost flatly, to the thin, very acutely carinated periphery; whorls about four, their edges distinctly visible in the umbilicus; the mouth very elongate, lanceolate, embracing three-fourths of the sides of the penultimate whorl. Surface of inner whorl spirally sulcated,[1] of the outer turns smooth, or with extremely fine, obsolete transverse lines of growth, having a very strong forward wave in the middle, and a small, slightly marked one at the sloping edge of the umbilicus.

[1] This ornamentation would be more correctly described as consisting of longitudinal (or spiral) ridges, since it is raised above the surface of the test; M'Coy's term implies a grooved or incised surface.

Internal casts show the septa strongly arching forwards from the umbilicus to a flat, solid band, about two or three lines wide, produced by the internal cavity not quite reaching the edge; the last chamber [body-chamber] occupies rather less than half the last whorl, and is marked by a narrow, deep sulcus, a little on the inner side of the middle, produced apparently by a corresponding ridge on the interior of the shell (Pl. XXVIII, fig. 3 *a*),[1] of which there is no trace on the outside. . . . I have not been able to observe the siphuncle in this species, but according to de Koninck it is very small and nearly central, a little outside of the middle. The inner whorl is scarcely embraced by the succeeding one, is not compressed, and has a broad, convex periphery; the next has a much more acute periphery, and is correspondingly embraced by the succeeding turn." (M'Coy, 'British Palæozoic Fossils,' fasc. iii, 1855, p. 560.)

I am indebted to the kindness of my friend Mr. G. C. Crick, of the British Museum, for the measurements given below, and he has also indicated to me by means of a diagram the exact position of the siphuncle, which he ascertained by temporarily separating the two halves of the specimen which had been united by an adhesive. It proves to be nearer the centre of the septum than de Koninck represents it to be,—that is, the height of the septum (the one measured was the last) being 35·5 mm., the siphuncle occurs at a distance of 20 mm. from the dorsal or wider extremity, and consequently 15·5 mm. from the peripheral or narrower extremity of it.

Dimensions.

	Specimen in "Gilbertson Coll.," British Museum.
Diameter of shell (without the test) . . .	85 mm.
,, umbilicus (with the test) . .	23 ,,
Greatest thickness of shell (without the test) measured at the anterior end of the body-chamber, below the curved line	15 ,,
The same at the last septum . . .	13·5 ,,
Depth of last four chambers (No. 1 being the last) as follows . . . . (1)	2·25 ,,
(2)	2·75 ,,
(3)	3 ,,
(4)	3 ,,

Affinities.—There is really no species which will bear comparison with the present one, which thus holds a solitary position among Palæozoic Nautiloids. De Koninck's comparison of it with the *Nautilus complanatus* of J. Sowerby ('Min. Conch.', 1821, vol. iii, p. 109, tab. cclxi) is not justified by the possession

[1] Seen on the cast of the body-chamber as a curved line following the contour of the shell.

of any specific characters common to the two species. Sowerby's species, with its wide umbilicus, numerous whorls, and sutures with sharply bent sinus, can have no affinities with a shell of the structure of *P. oxystomum*.

It has already been pointed out by de Koninck[1] that the species referred to the present one by H. Trautschold[2] has no affinities with it. This species of Trautschold, to which de Koninck has given the name *Nautilus Rouillieri* (loc. cit.), has since been figured by M. Tzwetaev (loc. cit.). The form of the sutures, which recalls that of *Hercoglossa*, is quite anomalous among the older palæozoic nautiloids. They are strongly and abruptly bent forwards along the margin of the umbilicus, and again bent, but in a wider curve and in the contrary direction, in the middle of the sides. The acute form of the periphery and the generally compressed habit of the shell are, indeed, the only features in which *N. Rouillieri*[3] resembles *P. oxystomum*. The two species are further distinguished by the fact that the umbilicus in the former is much smaller than in the latter.

Remarks.—If the figure given by de Koninck in his 'Calcaire Carbonifère,' pt. 1, pl. xvii, were correct, it would lead to the supposition that the Belgian species of *Phacoceras* was not identical with the one figured and described by Phillips under the name of *P. oxystomum*. De Koninck's figure represents a species with an umbilicus relatively much smaller than that of the last named. The figure given by de Koninck in his 'Description des Animaux Fossiles,' etc., pl. xlix, is much more accurate in this respect; both give a view of the inner whorls, the importance of which, from the classificatory point of view, has been well pointed out by Hyatt.[4] It is on the ground that the young have the form and proportions of *Discitoceras* that he gave *Phacoceras* the temporary place here assigned to it; but it is evident that further investigations will be necessary before the question of the true affinities of this singular genus can be solved. It is, however, a rare fossil.

It is unfortunate that the only specimen accessible to me for purposes of description and representation in the accompanying plate (Pl. XXVIII) is not localised. The occurrence of the species in Ireland is, however, well authenticated, Phillips and Griffith (in M'Coy's 'Synopsis') both referring to it; the former as occurring at Florence Court, near Enniskillen, the latter at Drumscraw

[1] "Faune Calc. Carb. Belgique" ('Ann. Mus. Roy. d'Hist. Nat. Belgique,' sér. Palæont., tom. ii), pt. 1, p. 124.

[2] 'Nouv. Mém. Soc. Imp. Nat. Moscou,' 1874, tom. xiii, p. 304, pl. xxx, fig. 7. See also M. Tzwetaev, 'Mém. Com. Géol. St. Pétersbourg,' 1888 vol., No. 3, pl. vi, figs. 33, 34.

[3] Assigned by Hyatt to his genus *Stenopoceras*, "Carboniferous Cephalopods." 'Geological Survey of Texas, Fourth Annual Report,' 1892, p. 446.

[4] "Carboniferous Cephalopods." Second paper. 'Geological Survey of Texas, Fourth Annual Report,' 1892, p. 438.

(Drumquin), in the county of Tyrone. Phillips records it also from the Isle of Man, and M'Coy ('British Palæozoic Fossils,' fasc. iii, 1855, p. 560) from Lowick, in Northumberland.

PHACOCERAS? RECTISUTURALE, sp. nov. Plate XXIX, figs. 2 *a*—*c*.

Description.—Shell (cast) somewhat compressed, discoid, with a deep umbilicus, in which the inner whorls must be partially if not wholly exposed; they are not visible in the (unique) specimen before me. The section of the whorls in the adolescent stage is pentagonal; expressed in more general terms it may be called sagittate. In the adult, owing to the rounding off of the periphery, it becomes roughly hexagonal. The periphery in the outer whorl is subacute as far as the body-chamber, towards the base of which it becomes more rounded, and forms a narrow ventral area. The body-chamber being imperfect, its size relative to the whole shell cannot be stated. The umbilicus is very deep with steep walls, the edge narrowly rounded—at least it is so in the cast. Owing to the rapid lateral expansion of the whorls the sides gain in depth with corresponding rapidity up to the body-chamber, near the base of which the greatest thickness of the shell, viz. 45 mm., is attained, from whence it quickly tapers towards the periphery (Pl. XXIX, fig. 2 *c*). So far as can be observed the overlapping of the whorls is very slight.

The septa are moderately distant from each other in the adolescent stage, their greatest width apart being here about 10 mm., but in approaching the body-chamber they become crowded together, the last two being only 3 mm. apart (Pl. XXIX, fig. 2 *a*). Their sutures are remarkably straight, especially near the body-chamber, indicating that the septa were extremely flat.

The siphuncle is not seen.

Only fragments of the test remain, and these are perfectly smooth.

Dimensions.

Diameter of shell	95 mm.
„ umbilicus	28 „
Height of outer whorl	43 „
Thickness at umbilical margin	45 „

Affinities.—In the present state of uncertainty as to the affinities of this fossil, chiefly owing to the want of the inner whorls, it seems scarcely advisable to attempt to compare it with any other species. I have always regarded it, however, as related, though perhaps remotely, to *Phacoceras oxystomum*, Phill., and to this, perhaps only fancied (as time may show), relationship I have given practical expression by putting it in the same genus. I would, however, beg of

those who are interested in the matter to consider this as a temporary act on my part, and one which is subject to revision should occasion require it.

The differences between the present species and *P. oxystomum* may, indeed, be taken in at a glance (cf. Pl. XXVIII, figs. 3 *a*, *b*). The stout form and remarkably straight sutures of the one are in marked contrast with the curved sutures and extremely attenuated habit of the other. The resemblance between them is reduced, in fact, so far as the outer whorl is concerned, to the common feature of an acute periphery.

Remarks.—In dealing with this new form two courses were open to me; one was to found a new genus for its reception, the other to merge it in one already known. I have chosen the latter alternative, because there is but a single individual, and its condition is such as to preclude the possibility of investigating the important characters which are afforded by the initial whorls, owing to their being partly destroyed, partly hidden by the matrix filling the umbilical depression. It must be left, therefore, to further research to supply this deficiency. Meanwhile the above description will serve to distinguish the fossil, and by its imperfect character draw attention to the fact that more information regarding it is a desideratum.

I am glad of this opportunity to express my indebtedness to Mr. G. H. Elliott, the Chief Librarian of the Free Public Library, Belfast, for kindly affording me every facility to examine and figure the specimen described above. It is contained in the collection of fossils made by the late Canon Grainger, D.D., M.R.I.A., of Belfast, who presented his large collections (ethnological, zoological, geological, etc.) to the institution just named, where they are under careful curatorship and are fully accessible to students.

Locality.—There is, unfortunately, no record, but as nearly all the fossils in the Grainger Collection came from Kildare, the chances are greatly in favour of the one here described having been obtained in that county.

[Vestinautilus carinifer*us*, *J. de C. Sowerby*, var. *triplicatus*, var. nov. Plate XXVIII, figs. 2 *a*, *b*. (See *supra*, p. 82.)

The very strong folds near the aperture (much too obscurely rendered in the figures) is so marked a feature in this individual, the only one known to me, that it demands particular notice. Only three folds are to be distinguished, the outer one of which bridges over the space extending from the edge of the umbilical keel to that of the aperture; this fold is flattened and rather inconspicuous. The

middle one, which is very prominent (much more so than the drawing indicates—fig. 2 *a*), curves forward from the border of the umbilical keel, and, taking a course corresponding nearly with the curvature of the hyponomic sinus, becomes obsolete before the centre of the latter is reached. The breadth of the folds nearly equals that of the space between them. Of the inner fold but little remains, as the test is here broken away, and it seems evident that the folds originated in a thickening of the test, there being only a slight trace of them upon the cast. In other features there seems to be nothing to distinguish this shell from *V. carinifera*, though the septation being covered by the test, its identity with that species is not quite so firmly established as could be wished. The body-chamber, where it is bare of the test, is very distinctly marked on the peripheral part by the "Runzelschicht" (Pl. XXVIII, fig. 2 *b*), which consists, as usual, of minute pits, lineally arranged, the lines conforming exactly with the contour of the aperture. The test shows fine lines of growth (seen also in fig. 2 *b*), somewhat irregularly spaced, and having naturally the same direction as those of the Runzelschicht.]

Family Coloceratidæ.

Genus Coloceras, *Hyatt*, 1893.

Coloceras Coyanum, *A. d'Orbigny*, sp. Plate XXX, fig. 3.

1844. Nautilus (Temnocheilus) pinguis, *F. M'Coy*. Synop. Carb. Foss. Ireland, p. 22, pl. iv, fig. 12 (*not* of L. G. de Koninck).
1847. — Hibernicus, *A. d'Orbigny*. Paléont. univers., tom. i, pl. ci, figs. 2, 3.
1850. — Coyanus, *A. d'Orbigny*. Paléont. stratigr., tom. i, p. 111.
1860. Temnocheilus pinguis, *R. Griffith*. Journ. Geol. Soc. Dublin, vol. ix, p. 56.
1878. Nautilus Coyanus, *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Palæont., tom. ii), pt. i, p. 101, pl. xxxi, figs. 2, 3.
1893. Coloceras Coyanum, *A. Hyatt*. Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 452.

Description.—Shell thick-discoid, subglobose, subhexagonal in transverse section until the body-chamber is reached, when the angularity of the sides becomes obsolete; the inner whorls exposed in a deep funnel-shaped umbilicus,

partly filled with matrix in the unique specimen now under description. The umbilicus is bordered up to the base of the body-chamber by a sharp keel, which completely disappears upon the body-chamber. The whorls overlap to the edge of the keel, which is thus concealed until the last whorl releases itself from its contact with the penultimate one. The periphery is rather broadly rounded, and presents longitudinally three rather ill-defined zones. The aperture has a deep hyponomic sinus. The body-chamber occupies about one-half of the last whorl. The test is smooth. Neither septa nor siphuncle are seen in the specimen before me.

Dimensions.

	Sci. and Art Mus., Dublin. M'Coy's type, "Griffith Coll."
Diameter of shell	52 mm.
,, umbilicus (from edge to edge)	30 ,,
,, ,, (from suture to suture)	19 ,,
Height of outer whorl (dorso-ventral)	21 ,,
Thickness at umbilical margin	28 ,,

Affinities.—There is ample justification for Hyatt's observation (loc. cit., p. 449) as to the resemblance of the shells included in the group *Coloceras* to those of *Vestinautilus*. At first sight there seems little of consequence to separate M'Coy's type from a young specimen of *V. cariniferus*, but a closer comparison shows that the latter has more numerous whorls and a proportionally wider umbilicus than the former, as already remarked by M'Coy. According to Hyatt also the developmental history of the two groups (*Coloceras* and *Vestinautilus*) is distinct. Comparing the present species with *C. bistrialis* (described below), Hyatt says that the former is a more slender and less involute shell than the latter, and the longitudinal ridges are not so persistent. He adds that "there are two good specimens [of *C. Coyanum*] in the Museum of Comparative Zoology (Cambridge, Mass.), which show that this and *C. globatus*, de Kon., as figured in the 'Calc. Carb.' (loc. cit.) [Pl. XXXI, figs. 1 *a*, *b* (not 1 *c*—*e*)], are probably identical." This may be so, but it must be understood that the *C. globatus* of de Koninck is not that of J. de C. Sowerby.

Remarks.—The figure of the type specimen (the only one extant) is reversed in the 'Synopsis;' it is represented in its natural aspect in the figure I have given of it (Pl. XXX, fig. 3). If this figure be compared with those on Pl. XXIII, numbered 1 and 2, it will be seen how close is the general resemblance of *Coloceras Coyanum* to *Vestinautilus cariniferus*.

Localities.—Kilmallock, near Limerick (M'Coy's type); Ballyduff, near Dungarvan, county of Waterford (*fide* Sir R. Griffith).

COLOCERAS BISTRIALE, *J. Phillips*, sp. Plate XXX, figs. 2 *a*—*c*.

1836. NAUTILUS BISTRIALIS, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 232, pl. xvii, fig. 21.
1844. — (TEMNOCHEILUS) BISTRIALIS, *F. M'Coy*. Synop. Carb. Foss Ireland, p. 20.
1891. CŒLONAUTILUS BISTRIALIS, *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 2, p. 130.
1893. COLOCERAS BISTRIALE, *A. Hyatt*. Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 451.

Description.—Shell small, globose, composed of about two and a half whorls, all exposed in a deep umbilicus. The apex is not seen, but it would appear that the form of the young shell, so far as can be made out, does not materially differ from that of the adult. The section of the whorls is roughly hexagonal, the periphery broadly rounded with a shallow median depression; from this the shell slopes on each side to the edge of the umbilicus. The latter has a sharp keel, which does not reach beyond the beginning of the body-chamber, whence the shell is obtusely rounded up to the aperture. This has a deep hyponomic sinus (very distinctly outlined on the body-chamber, Pl. XXX, fig. 2 *c*), with its edge sharply reflected (fig. 2 *a*). Two fine but distinct ridges encircle the inner whorls just within the umbilical keel, this ornamentation having suggested the specific name. The test is quite smooth. Distinct traces of the Runzelschicht are seen upon the cast of the body-chamber in one of the specimens before me.[1]

Neither septa nor siphuncle are known.

Dimensions.

	Specimen figured Pl. XXX, fig. 2.
Diameter of shell . . .	50 mm.
,, umbilicus (from edge to edge)	33 ,,
,, ,, (from suture to suture)	22 ,,
Height of outer whorl (without the test) .	18 ,,
Breadth ,, ,, ,, .	27 ,,

Affinities.—*Nautilus globatus*, de Koninck[2] (not J. de C. Sowerby), resembles the present species in having a series of ridges encircling the umbilical walls, but

[1] A nearly perfect specimen (figured loc. cit.) contained in the Museum of Science and Art, Dublin (Geological Survey Collection).

[2] Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., tom. ii), pt. i, p. 95, pl. x, figs. 4 *a*, *b* (excl. figs. 2, 3).

the shell expands much more rapidly than Phillips's, and cannot be considered identical with it.

I am not able to agree with de Koninck in regarding the present species as identical with J. de C. Sowerby's species *Nautilus globatus* (= *Planetoceras globatum*, Hyatt, *supra*, p. 96). The distinctive character of that species is the laterally spreading form of the last whorl, with its excessively wide, dorso-ventrally contracted aperture. This expansion of the whorl is always seen commencing in the young shell, and this in individuals quite as small as the one figured in the plate accompanying this description (Pl. XXX, fig. 2 *a*). Besides this, *P. globatum* has no keels or ridges on the umbilical walls; it has only the keel on the edge of the umbilicus, very strongly developed in the adult shell. Another feature, absent in *Coloceras bistriale*, is very marked in *P. globatum*, and that is the last whorl being produced beyond the coiled part of the shell, so that the aperture never touches the penultimate whorl.

C. bistriale is easily distinguished from *C. Coyanum* by its relatively much larger umbilicus, and by the ridges that encircle the umbilical walls.

Localities.—Clane, county of Kildare; Tomdeeley, county of Limerick.

Family Solenocheilidæ.

Genus Aipoceras, *Hyatt*, 1883.

Aipoceras compressum, *A. H. Foord.* Plate XXX, figs. 1 *a*, *b*.

1891. Gyroceras (Aipoceras) compressum, *A. H. Foord.* Cat. Foss. Ceph. British Museum, pt. 2, p. 68, figs. 6 *a*, *b*.

1893. Aipoceras compressum, *A. Hyatt.* Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 454.

Description.—Shell compressed, composed of about two volutions which are not in contact; these increase in diameter with moderate rapidity. The section is roughly trigonal or cuneiform. The initial point is somewhat obtuse; it bears no trace of a cicatrix. The dorsal area, which is completely exposed, is proportionally broad and flattened, and slightly raised along the median line, falling away on either side of this to the subangular umbilical margin. The sides are also flattened, and their junction with the narrowly rounded periphery is undefined.

The body-chamber is very large, occupying about two-thirds of a volution. There is a slight emargination on the superior border of the aperture, representing the hyponomic sinus.

The septa are moderately distant from each other, indicating shallow chambers. The sutures are very slightly curved backwards upon the sides of the shell, bending a little forwards on the peripheral margin, and crossing the periphery with a very slight backward curvature.

The sutures exposed to view give the following depth for the chambers, reckoned from the body-chamber posteriorly, measurements being taken at about the middle of the lateral area :

1	11·0 mm.
2	16·0 ,,
3	15·5 ,,
4	14·0 ,,
5	12·5 ,,
6	11·0 ,,
7	9·5 ,,
8	8·0 ,,

The siphuncle is ventral.

The test is perfectly smooth.

Dimensions.

	Large specimen from Clane in Science and Art Museum, Dublin.
Diameter of shell	170 mm.
,, umbilicus	50 ,,
Height of whorl on body-chamber at about 65 mm. from its base	84 ,,
Thickness at edge of umbilicus near base of body-chamber	55 ,,

Affinities.—The distinctly wedge-shaped whorl and the compressed form of the shell in this species distinguish it completely from *Aipoceras gibberosum*, de Koninck, sp., the only one with which it can be compared.

Remarks.—These evolute forms of the Solenocheilidæ are singularly interesting, because they supply one of the links in the chain that connects the straight shells of the Carboniferous seas and those which are curved, or partially curved, with the completely involute ones. Their relationship with *Asymptoceras* and *Solenocheilus*, so far as the form of the shell can dictate it, seems to be clearly made out. The triangular section of the whorl, the ventral position of the siphuncle, and the nature of the septa are similar, except in minor particulars, to those of the genera named. It is only in the matter of uncoiling that they stand alone among the Solenocheilidæ.

The same connection between simply curved and evolute shells and involute

ones may be traced in the genus *Trigonoceras* (through its two species, *T. paradoxicum* and *T. rigoceras;* the one coiled only in the earlier stages of the young shell, the other evolute), and the more or less closely coiled (involute) shells represented in the genera *Cœlonautilus*, *Aphelecerus*, and others of their tribe.

Locality.—Clane, county of Kildare.[1]

Genus ACANTHONAUTILUS, *Foord*, 1896.

ACANTHONAUTILUS BISPINOSUS, *A. H. Foord.* Plate XXVIII, fig. 1; Plate XXIX, fig. 1.

1896. ACANTHONAUTILUS BISPINOSUS, *A. H. Foord.* Ueber die Orthoceren des Kohlenkalks (Carboniferous Limestone) von Irland. . . Inaugural-Dissertation zur Erlangung der Doktorwürde . . . der Kgl. bayer. Ludwig-Maximilians-Universität zu München, p. 42.

1897. — — *A. H. Foord.* Geological Magazine, New Series, decade 4, vol. ix, p. 147, pl. vi; also J. F. Blake, ibid., p. 287.

1900. — [BISPINOSUS], *A. Hyatt.* In the translation of Karl A. von Zittel's Text-book [Grundzüge] of Palæontology, edited by Charles R. Eastman,[2] p. 525.

Description.—Shell of medium size, nautilus-like in its general habit, somewhat globose, and expanding rapidly; consisting of about two or two and a half volutions, the inner ones concealed by the lateral expansion of the shell. The peripheral area is broadly rounded and somewhat flattened on the body-chamber, especially towards the aperture in the adult, but more narrowly and evenly rounded in the younger stages of growth. The umbilicus is rather large and very distinctly funnel-shaped. It is provided with a thick and very conspicuous rim, which is produced into long, flat, hollow, spine-like processes, projecting almost at right angles to the longitudinal axis of the shell on each side of it. The spines,

[1] A small, remarkably well-preserved specimen of this species is contained in the British Museum.

[2] With the exception of a few introductory pages, the whole of the class Cephalopoda in this work has been revised and in great part rewritten by Professor Hyatt, who has introduced a new classification for the larger groups, and many new genera. He has also added a very copious and useful bibliography.

whose flatness is nearly on the same plane as the adjacent part of the surface of the peripheral area, are greatly expanded at the base, but become rapidly narrow towards their distal end, their basal portion merging with a slight concavity in the general surface of the ventral part of the shell on the outer side, while on the inner side they are continuous with the umbilical margin. The spines are met anteriorly by the border of the aperture, posteriorly by the rim of the umbilicus, from which they proceed on that side. They thus make here a curve on their inner edge, which is directed outwards and slightly downwards at the same time. The direction of the spines in relation to the longitudinal axis of the shell is nearly that of a right angle, with a slight curvature of the flattened aspect inclining away from the periphery and towards the umbilicus.

Both of the spines are imperfect, one having been broken off near the base, the other wanting a portion of the extremity. The former is seen to begin with two diverging folds of the shell, originating as above described. These make an angle, as seen in the section of the broken stump, the blunt apex of the angle being formed by the rim, already described as an extension of that of the umbilicus. The two folds rapidly approach each other, till, as the more perfect spine shows, they run nearly parallel, forming a flattened tube up to the end of the spine, as far as it is preserved. The flattening here referred to may be partly due to pressure in the rock; but, on the other hand, the pinched appearance of the two folds of the shell near the base of the spine, where there is no evidence whatever of crushing, is already so marked as to contradict the supposition of flattening by any such accidental agency.

The outline of the aperture, which can be distinctly traced, is curved gently forward on either side, and forms in the centre a broad and shallow hyponomic sinus.

The sutures, of which only five are visible, are moderately distant, the last two somewhat closer together than the rest. The septa have been completely destroyed by the deposition of crystalline calcite in the chambers, the removal of a great part of this calcite disclosing no traces of them; nor were any remains of the siphuncle met with.

The distances between the septa which are exposed to view, measured from the posterior to the anterior one, are 14 mm., 17 mm., 13 mm., and 12 mm., the last one measured being probably next to the body-chamber.

The test is quite smooth, only slightly marked lines of growth occurring on the body-chamber.

Dimensions.

	Specimen in Museum of Science and Art, Dublin.[1]
Diameter of shell	160 mm.
,, umbilicus	25 ,,
Height of outer whorl (dorso-ventral)	80 ,,
Thickness at umbilical margin	100 ,,
Width of shell (ventrally) just above the origin of the spines	120 ,,
Width of periphery at aperture of shell	90 ,,

Affinities.—I have drawn attention elsewhere[2] to the resemblance between the present species and the one described under the name of *Nautilus cornutus* by Golowkinsky,[3] from the Permian formation of the central part of the basins of the rivers Kama and Volga. I am now enabled, through the kindness of a friend, to give a translation of the original description from the Russian of that author, by which the two species may be more satisfactorily compared. It runs as follows:—"It [*N. cornutus*] has three or four whorls, which grow quickly in breadth, forming a deep umbilicus; each whorl covers about half of the preceding one, and has, when cut transversely, the form of a crescent with rounded ends. The periphery is flattened in large specimens. The sutures form a slightly waved line, which curves backwards on the umbilical whorl and on the sides of the shell, and more slightly so upon the periphery. The siphuncle lies nearer to the umbilicus than to the periphery, and is therefore a little below the centre of the septa. The body-chamber occupies approximately one-third of the last whorl, and presents at the aperture a roundish contour, with a sharp angle on each side where the lateral margin unites with the umbilical wall. Here, taking a course almost at right angles to the periphery, a tubular process [spine] is formed, which juts out from each side of the aperture like a horn.

"Thus the horn-like spines are formed by a fold in the test, which unites along a line extending outwards from the lower angle of the apertural margin. The extremity of the spines is open. Their general direction is nearly at right angles to the longitudinal axis of the shell; but they have a strong upward inclination, and are also slightly curved. In the large specimen [figured], measuring 100 mm. in diameter, the length of the spines is 55 mm. The periphery at the aperture projects a little in front of the spines. The surface of the shell is covered with fine lines, which, upon the periphery, form a backwardly directed, very small

[1] A cast has been deposited in the British Museum.

[2] 'Geological Magazine,' New Series, decade 4, vol. iv, p. 287.

[3] 'Matériaux pour la Paléontologie Russe,' tom. i, 1869, p. 381, tab. v, figs. 15—19.

angular sinus, through the centre of which there runs longitudinally a slight keel or raised line. The sinus forms a little notch in the margin of the aperture.

"The greatest diameter of the shell is 100 mm., the greatest width 80 mm., the greatest height 45 mm.; length of spines, 55 mm.

"The extension of the last chamber into horn-like processes reminds one of *Nautilus Seebachianus*, Geinitz (Dyas, Bd. i, S. 43, Taf. ix, fig. 7), which has a leaf-like expansion of the body-chamber extending longitudinally and laterally. The likeness of form is shown by the raised line or keel which passes along the centre of the periphery, and is absent in *Nautilus Freieslebeni*.

"R. Ludowick, who has seen a specimen of this species in the Geological Museum of the Kazan University, calls it *Nautilus Freieslebeni* (Dyas, Bd. ii, S. 295), and indicates Nijini Tyvesniak, in the vicinity of Kazan, as the place where it is found. This is not correct, as I found it myself, in the year 1859, in the Verchni Tyvesniak, at the mouth of the Tanassalka. It is very often found in the Verchni Tyvesniak, on the Volga, at a little distance between Bourtas and Antonovka, especially near the village of Krasnovidof."

From this description it may be gathered that the two species differ in the following particulars:—In *Acanthonautilus bispinosus* the shell has fewer whorls, and the spines have not the upward curvature which is such a marked feature in the Russian species. Further, the septa are much less numerous in the former species than they are in the latter. There is also a very broad though shallow hyponomic sinus in the aperture of *A. bispinosus*, while in *A. cornutus* this structure is scarcely more than a notch. Lastly, the umbilical border in *A. cornutus* is distinctly angular, with steep sides; in *A. bispinosus*, on the other hand, it has a rounded rim. Hence there seems to be amply sufficient ground for separating the two species, whose resemblance is restricted to the spines which each possesses.

Remarks.—It would seem from Golowkinsky's description that *Acanthonautilus cornutus* was not an uncommon species—at least in the district where it was found.

From a list of the fossils of the region given by Golowkinsky in his memoir, it appears that they are typical of the lower Zechstein division of the Dyas of Germany. Hence the horizon of *Acanthonautilus* has been extended vertically by the discovery of the Irish species, which can thus boast of a somewhat greater antiquity than its Russian congener.

That *A. cornutus* should have been completely overlooked by palæontologists till within the last few years is, perhaps, not very remarkable, the description being contained in a journal, apparently not well known out of Russia, printed in Russian, and containing no abstract in German or French by which its valuable contents would be made known to the student unacquainted with that language.

This serious drawback is partly redeemed by the excellent lithographic illustrations of the fossils described in the text.[1]

The generic affinities of *Acanthonautilus* are clearly those which are indicated in Professor Hyatt's association of it in the family Solenocheilidæ;[2] and if the spines had been absent the two species representing the genus would have fallen naturally into the genus *Asymptoceras*.

Locality.—Clane, county of Kildare.

Genus Asymptoceras, *Ryckholt*, 1852 (emend. *Hyatt*, 1883, 1893).

Asymptoceras crassilabrum, sp. nov. Plate XXXI, figs. 1, 2.

Description.—Shell nautilus-like in general form and aspect, the whorls increasing rapidly, subquadrate in section from an early stage of growth, and more distinctly so in the adult; the sides broad and flattened, the periphery slightly depressed along the median line, its breadth considerably less than that of the shell at the umbilical margin owing to the upward convergence of the sides. Umbilicus deepening rapidly as the shell expands, the initial whorl leaving an oval vacuity. The aperture has apparently a shallow hyponomic sinus on the periphery, and in front the lip forms a prominent rounded rim, caused by its inward folding. This rim does not extend beyond the walls of the umbilicus.

The body-chamber occupies about one-half of the last volution.

The septa are very wide apart. Where the breadth of the periphery is 20 mm. they are 13 mm. apart, where it has increased to 50 mm. in breadth they are 24 mm. apart; and the measurements of the last chamber give for the periphery and septa respectively 55 mm. and 20 mm.

The ventral siphuncle, characteristic of the Solenocheilidæ, is seen in a large specimen, from which some of the shell has been broken away, in the shape of a slender tube about 3·5 mm. in diameter, partly buried in the rock which fills the chambers. The test is apparently smooth everywhere except upon the rim which borders the front of the aperture, where there is a series of fine and regular lines running parallel with its edge.

The impression of the shell muscles is plainly indicated on one of the specimens before me. It consists of a fine incised line about 4 mm. above the basal edge of the body-chamber, running nearly parallel thereto in the umbilicus and on the sides of the shell, but becoming slightly deflected upon the periphery, where

[1] The copy of the work to which I fortunately gained access is contained in the admirably equipped library of the Geological Society of London, Burlington House.

[2] Loc. cit.

it is nearly double the distance from the basal edge of the body-chamber that it was on the sides, viz. 8 mm., making here a depressed arch. Exactly in the centre of the periphery this arch culminates in a small sinus, after which the same phenomena are repeated on the other side.

Dimensions.

	Specimen from Clane, in Science and Art Museum, Dublin, figured Pl. XXXI, fig. 2.
Diameter of shell . . .	180 mm.
,, umbilicus (edge to edge) .	68 ,,
,, ,, (suture to suture) .	40 ,,
Height of whorl (dorso-ventral) .	110 ,,
Thickness at umbilical margin .	105 ,,
Breadth of periphery near the aperture .	83 ,,

All the above measurements are taken from the specimen indicated, except the last, which was taken from the one represented by fig. 1 on the same plate, as the periphery in this was more perfect.

Affinities.—The most nearly related species to the present one is that described below—*Asymptoceras Foordi*, Hyatt,—but the distinction between them is strongly marked. Instead of the lip-like rim in front of the aperture, which is the characteristic feature of *A. crassilabrum*, there is in *A. Foordi* a broad swelling here, causing the body-chamber to be produced beyond the penultimate whorl to a much greater extent than is the case with the former species. Besides this, *A. Foordi* is considerably contracted at the aperture, and the periphery is broadly arched instead of being flattened, and even slightly concave, as in *A. crassilabrum*

Remarks.—I drew attention on a former occasion [1] to the fact that the names *Vestinautilus* and *Asymptoceras*, as previously pointed out by de Koninck,[2] were based on errors of observation on the part of their author, Baron de Ryckholt.[3] Hyatt, however, has restored and given currency to both these names, first in his "Genera of Fossil Cephalopods," [4] and more recently in his "Carboniferous Cephalopods." [5]

In spite of cogent reasons that might be urged against the retention of names founded upon erroneous data, the fact that de Ryckholt indicated the species to which he intended his generic names to be applied may be held partly to justify their use, though not dispensing with the necessity for defining the genus.[6] It is,

[1] 'Cat. Foss. Ceph. British Museum,' 1891, vol. ii, p. 167.

[2] 'Faune Calc. Carb. Belg.,' 1878, pt. 1, p. 86.

[3] 'Notice sur les genres *Nautilus*, *Vestinautilus*, *Asymptoceras*, *Coya*, et *Terebrirostra*,' p. 4.

[4] 'Proc. Boston Soc. Nat. Hist.,' 1883, pp. 294, 296.

[5] 'Geol. Surv. Texas, Fourth Annual Report, 1892' (reprint, 1893), pp. 419 and 456.

[6] Loc. cit., pp. 77—88.

indeed, quite possible that the obscure pamphlet in which *Vestinautilus* and *Asymptoceras* were introduced might have escaped notice had not de Koninck directed attention to it in his summary of the history of the family Nautilidæ (loc. cit.). Their resuscitation by Hyatt has at least the merit of sparing science the infliction of two new names which must have been found for the group of species split off by him from *Celonautilus* and *Solenocheilus*, to the former of which groups the name *Vestinautilus* is now applied (type, *Nautilus Koninckii*, d'Orb.), to the latter the name *Asymptoceras* (type, *N. cyclostomus*, Phill.). The types here referred to were both indicated by de Ryckholt himself in the pamphlet quoted above.

Locality.—Clane, county of Kildare (the only place in which this species has yet been found).

Asymptoceras Foordi, *A. Hyatt.* Plate XXXII, figs. 1 *a*, *b*, 2, 3.

1891. Solenocheilus conspicuus, *A. H. Foord.* Cat. Foss. Ceph. Brit. Mus., pt. 2, p. 175, figs. 31 *a*, *b* (*not* of L. G. de Koninck).

1893. Asymptoceras Foordi, *A. Hyatt.* Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 459.

Description.—Shell nautilus-like, with about two rapidly increasing whorls, which contract towards the aperture. Section subquadrate. The sides broad, merging imperceptibly into the periphery, which is narrowly rounded in the young and adolescent stages of growth, but from the body-chamber to the aperture it becomes much more broadly rounded, the contraction beginning at about the last fourth of the body-chamber.

The aperture presents a wavy line, forming a broad and shallow sinus at the sides of the shell, and a deeper hyponomic sinus upon the periphery. In front it is slightly curved forward. Here there is a prominent rim or swelling extending from one umbilical margin to the other, and causing the lip of the aperture to be bent inwards. This swelling naturally makes the body-chamber project a little from the rest of the whorl. The umbilicus, the edge of which is obtusely angular, deepens rapidly after the first whorl is completed, the initial whorl leaving a small vacuity in its centre.

The zone of impression is very shallow and indistinct.

The incised impression of the shell muscles is more or less distinctly marked upon the cast of the body-chamber in three of the specimens before me. It forms a widely arched, forwardly directed curve from the umbilical margin to the centre

of the periphery, repeating a similar curve on the other side. On the wall of the umbilicus the impression runs nearly parallel with the basal edge of the body-chamber.

The chambers are moderately deep. The last six (leaving the body-chamber out of account) give the following measurements,[1] No. 1 in the table representing the last chamber, No. 2 the penultimate, and so on.

[*Note.*—The measurements are taken at about the middle of the lateral area. See Pl. XXXII, fig. 1 *a*.]

1	13·0 mm.
2	15·5 ,,
3	14·0 ,,
4	13·5 ,,
5	10·5 ,,

The siphuncle traverses the margin of the periphery in the median line (Pl. XXXII, figs. 1 *b* and 2).

The test is perfectly smooth except upon the apertural inflation, where there are lines of growth in the shape of faint ridges regularly disposed, and having a curvature which corresponds with that of the margin of the aperture.

Dimensions.

	Large Specimen from Clane, in Science and Art Museum, Dublin.
Diameter of shell	149 mm.
,, umbilicus (edge to edge)	49 ,,
,, ,, (suture to suture)	25 ,,
Height of whorl (dorso-ventral)	84 ,,
Thickness at centre of lateral area (without test)	92 ,,
,, aperture	82 ,,

Affinities.—The relationship between the present species and *Asymptoceras crassilabrum*, Foord, has been pointed out above in the description of the latter. It is more nearly related to *A. conspicuum*, de Kon.,[2] sp. But the latter, as observed by Hyatt,[3] is not so closely coiled, nor is the body-chamber produced beyond the earlier part of the last whorl, as in *A. Foordi*. The sutures also are more numerous and more sinuous in de Koninck's species than they are in Hyatt's.

[1] Mr. G. C. Crick kindly supplied me with these measurements from the specimen in the British Museum, which I have figured.

[2] 'Faune Calc. Carb. Belg.,' pt. 1, p. 109, pl. xix, figs. 1 *a*—*c*; pl. xx; pl. xxi, figs. 1 *a*, *b*.

[3] 'Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report,' 1892, p. 459.

Remarks.—This species is only known to me from Clane, in the county of Kildare, and from Rathkeale, near the town of Limerick; but its presence in other localities in Ireland may very probably be demonstrated when the search for fossils becomes more systematic and wide-spread throughout the country. The quarries at Clane have yielded several specimens, whose aggregate features furnish all the data necessary for the full description of the species.

Localities.—Clane, county of Kildare; Rathkeale, near Limerick.

Genus SOLENOCHEILUS, *Meek and Worthen*, 1870 (emend. *Hyatt*, 1883, 1893).

SOLENOCHEILUS DORSALIS, *J. Phillips*, sp. Plates XXXIII, XXXIV.

1836. NAUTILUS DORSALIS, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 231, ? pl. xvii, fig. 17; pl. xviii, figs. 1, 2.
1843. — — *J. E. Portlock*. Geology of Londonderry, p. 405.
1849. CRYPTOCERAS DORSALIS, *A. d'Orbigny*. Prodr. de Paléont. Stratigr., vol. i, p. 114.
1875. NAUTILUS DORSALIS, *W. H. Baily*. Characteristic British Fossils, p. 117, pl. xl, fig. 7.
1876. — — *Armstrong, Young, and Robertson*. Catalogue of Western Scottish Fossils, p. 59.
1883. ASYMPTOCERAS DORSALE, *A. Hyatt*. Genera of Fossil Cephalopods. Proceed. Boston Soc. Nat. Hist., vol. xxii, p. 297 (foot-note).
1891. SOLENOCHEILUS DORSALIS, *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 2, p. 169, fig. 27 (p. 166)—type specimen.
1893. — — *A. Hyatt*. Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 460.

[Not 1878. *Nautilus dorsalis*, L. G. de Koninck. Faune Calc. Carb. Belg. (Ann. Mus. Roy. d'Hist. Nat. Belg., tom. ii), p. 111, pl. xxviii, figs. 1—3. (? var. γ of Phillips.)]

Description.—Shell large, nautilus-like, subglobose, consisting of about two rapidly enlarging involute whorls, the last overlapping the preceding one to the extent of about two-thirds. Umbilicus proportionately small, exposing the inner whorl, having a small central vacuity; the sides steep, with rounded margins which are merged in the sides of the shell. The section is broadly sagittate, the periphery forming the apex of the triangle.

The body-chamber is large, extending to about two-thirds of the circumference of the whorl. The periphery is somewhat narrowly rounded, the sides diverging outwardly from it, very slightly in the first whorl, but much more strongly in the

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MONOGRAPH

ON THE

CARBONIFEROUS CEPHALOPODA

OF

IRELAND.

BY

ARTHUR H. FOORD, Ph.D. (Münch.), F.G.S.

PART IV.

CONTAINING THE FAMILIES

SOLENOCHEILIDÆ (CONCLUDED) AND GLYPHIOCERATIDÆ.

Pages 127—147; Plates XXXIII—XXXIX.

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last. At the edge of the umbilicus, where the lower margin of the aperture meets the lateral margins, there is a distinct swelling, a characteristic feature seen in all individuals of the species in which the aperture is preserved at this point (Pl. XXXIII). With the complete form of the aperture and its hyponomic sinus I am unacquainted, as I have not met with any specimens in which it is preserved; nor are the lines of growth sufficiently distinct to indicate its nature in the specimens known to me.

The septa, as indicated by their sutures, are wide apart. In a large specimen from Rathkeale, near Limerick (Pl. XXXV,[1] fig. 1), the diameter of which is approximately 230 mm., the distances between the sutures in the last six chambers, measured along the median line of the periphery (reading them towards the body-chamber), are as follows:—28 mm., 28·5 mm., 29 mm., 34 mm., 32 mm., 35 mm.[2]

The siphuncle has a diameter near the body-chamber of about 4 mm.; it lies immediately under the test, so that the removal of the latter exposes it. The test is marked only by very faint lines of growth.

Affinities.—The most nearly related species is *Solenocheilus evolutus*, Hyatt[3] (= *Nautilus dorsalis*, de Kon.,[4] *not* Phillips), but the whorls in this species are only just in contact instead of overlapping considerably as is the case with *S. dorsalis*, Phill. Hence the renaming of de Koninck's species by Hyatt.

From *S. latiseptatus*, de Kon.,[5] the present species differs in its much narrower periphery, more rapid rate of tapering, and overlapping whorls, as well as in its relatively closer septation.

Remarks.—The Irish specimens of this species agree well with Phillips's type (form *a*, from Bolland, Yorkshire), which I had the opportunity, through the kindness of Dr. Henry Woodward, F.R.S., of re-examining at the British Museum in the summer of 1900. They have the characteristic narrowly rounded periphery possessed by the type specimen. The sutures are not seen in the latter, which has, however, part of the body-chamber intact. The test is badly preserved, its surface having been entirely destroyed by a crystalline deposit.

S. dorsalis is widely distributed in Ireland, where it attains a very considerable size. The largest I have met with is now in the British Museum; it was found in the quarries at Clane. I give its dimensions, kindly supplied to me

[1] This plate, having been added after the publication of Part III of the present Monograph, is not enumerated at the head of the description of this species on page 126.

[2] These measurements will not be found to agree precisely with the drawing, owing to the position of the lines in the latter being naturally affected by the curved surface of the shell.

[3] "Carboniferous Cephalopods." Second paper. 'Geological Survey of Texas, Fourth Annual Report,' 1892, p. 460.

[4] "Faune Calc. Carb. Belg.," 1878 ('Ann. Mus. Roy. d'Hist. Nat. Belg.,' tom. ii), pt. 1, p. 111, pl. xviii, figs. 1—3.

[5] Ibid., p. 110, pl. xxii, figs. 1—3. Also 'Cat. Foss. Ceph. Brit. Mus.,' 1891, pt. 2, p. 171, fig. 29.

by my friend Mr. G. C. Crick; adding to it the measurements of the large specimen I have figured in this Monograph (Pls. XXXIII, XXXIV). It will be seen that there is very little difference in size between these two specimens.

In the synonymy of this species given in Part III, p. 126, of this Monograph, I have suggested that *Nautilus* [*Solenocheilus*] *dorsalis* of de Koninck (not of Phillips) may be the var. γ of Phillips ('Geol. York.,' 2, pl. xviii, figs. 1, 2), overlooking the fact stated above, that Hyatt ('Geological Survey of Texas,' 1892, p. 460) had renamed de Koninck's species, calling it *Solenocheilus evolutus*, in allusion to its evolute whorls.

Dimensions.

	Large specimen from Clane, in the British Museum (No. C. 4626).	Large (figured) specimen from Clane, in Dublin Museum of Science and Art.
Diameter of shell	240 mm.	230 mm.
„ umbilicus (suture to suture)	—	40 „
Height of whorl (dorso-ventral)	—	133 „
Thickness at umbilical margin of aperture (about)	160 mm.	150 „

Localities.—St. Doulagh's, county of Dublin; Clane, county of Kildare; Rathkeale, near Limerick; Blackrock and Little Island, near Cork; and Kilcommoch, county of Longford. (The last three localities are cited in Sir Richard Griffith's 'Localities of Irish Carboniferous Fossils,' forming an appendix to M'Coy's 'Synopsis,' issue of 1862.)

SOLENOCHEILUS ? HIBERNICUS, *A. H. Foord*. Plate XXXVI, figs. 1 *a*, *b*, 2.

1836. NAUTILUS DORSALIS (var. β), *J. Phillips*. Geology of Yorkshire, pt. 2, p. 231.

1891. SOLENOCHEILUS HIBERNICUS, *A. H. Foord*. Cat. Foss. Ceph. British Museum, pt. 2, p. 171, fig. 28.

1893. — — *A. Hyatt*. Carboniferous Cephalopods. Second paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 461.

Description.—Shell of medium size, so far as the species is known, nautilus-like, subglobose, consisting of about one and a half rapidly expanding involute whorls, the last overlapping the preceding one to the extent of about three-fourths. Umbilicus proportionately small, exposing the inner volution, with a central vacuity of moderate size; the sides steep, with a distinctly angular margin.

The section is broadly sagittate, the periphery constituting the apex of the triangle.

The body-chamber is large, extending to about three-fourths of the circumference of the last whorl. The periphery is rather narrowly rounded, and merges in the sides as they gradually expand towards the edge of the umbilicus. The aperture is not preserved in any of the specimens that have come under my notice. The apex, so far as it can be observed, is obtusely pointed as in other shells belonging to this genus.

The septa, as indicated by the sutures, are somewhat widely separated. In a specimen contained in the "Gilbertson Collection" at the British Museum (No. C. 212), from Bolland, Yorkshire (Pl. XXXVI, fig. 2), the sutures increase from a distance of 10 mm. to one of 20 mm. apart where the diameter of the shell is 76 mm. The siphuncle is not known, but it is assumed to be peripheral, hence the reference of the species to *Solenocheilus*. The surface of the shell is perfectly smooth.

Dimensions.

	Type specimen in the British Museum (No. C. 4505).	Specimen in British Museum ("Gilbertson Collection," No. C. 212).
Diameter of shell (about)	117 mm.	91·5 mm.
„ umbilicus (edge to edge)	24 „	17 „
„ „ (suture to suture)	18 „	— „
Height of whorl (dorso-ventral) about	67 „	— „
Thickness at umbilical margin	82·5 „	85 „

Affinities.—The angularity of the umbilical margin distinguishes this species from *Solenocheilus dorsalis*, which it resembles in its general form and septation; and this seems to justify its reference to *Solenocheilus*, though the siphuncle is unknown. *S. atlantoideus*, de Koninck,[1] though possessing a similarly angulated umbilical margin, has a very different form in cross-section, caused by its more broadly rounded periphery, while it has also at least one whorl more than *S. hibernicus*, giving the umbilicus a much greater width.

Remarks.—This species is represented in the Dublin Museum of Science and Art by a recently acquired specimen from Little Island, near Cork. Like many of the Carboniferous Limestone fossils from this part of the south of Ireland, it is greatly distorted, the peripheral area being completely flattened in the region of the body-chamber in the dorso-ventral direction, causing the sides of the shell to be much narrowed and the periphery proportionately widened. The flattening and distortion has also affected the septate part of the shell, which is squeezed into an elliptical form. The angular edge of the umbilicus is marked by a narrow rim,

[1] "Faune Calc. Carb. Belg.," 1878 ('Ann. Mus. Roy. d'Hist. Nat. Belg.,' tom. ii), pt i, p. 97, pl. xi, figs. 1, 2.

which expands in the vicinity of the aperture in such a manner as to show that its margin had the spout-like projection which is one of the characteristics of *Solenocheilus*.

I have described this individual somewhat in detail in order to point out how completely rock-pressure may transform a fossil so that it may, as in the present case, put on a shape which is quite foreign to its normal one.

Localities.—Little Island, near Cork; Ireland (precise locality unknown; this is the type specimen in the British Museum).

SOLENOCHEILUS ? CLAUSUS, sp. nov. Plate XXXVI, fig. 3.

Description.—Shell (known only in the adult stage) nautilus-like, inflated, with rapidly expanding whorls, the inner ones concealed by the last one. The sides broad, somewhat compressed, and merging in the widely rounded periphery. The outline of the aperture, which is only partially preserved, forms a broad curve at the sides, and where it meets the umbilical margin is reflected inwards, forming a flattened, slightly concave, thickened band (callus), which enters and closes the umbilicus.

The sutures, of which only five are seen owing to the presence of the test, are rather widely separated from each other. Measured from the last they are respectively 15 mm., 15 mm., 14 mm., and 12 mm. apart. The siphuncle is not seen. The test is represented apparently only by the thin inner layer, which is perfectly smooth.

Dimensions.

	Specimen in British Museum (No. C. 7967).
Diameter of shell	140 mm.
Height of whorl at aperture about . .	60 „
Thickness at umbilical margin close to the aperture (perhaps somewhat affected by distortion) .	120 „

Affinities.—I am not acquainted with any species with which *S. clausus* may be compared.

Remarks.—The completely closed umbilicus is the distinguishing mark of the present species, and, so far as my observation carries me, this is uncommon among the Nautiloids, the tendency in this group being to leave the inner whorls more or less exposed even in those species which approximate most closely to the recent *Nautilus* in their general form, which on the whole is the case with the Solenocheilidæ.

Unacquaintance with the siphuncle throws some doubt on the generic position

of this species, as was the case with *Solenorcheilus? hibernicus*, and its reference to that genus may possibly prove to be erroneous.

It is interesting to note among these very ancient Cephalopods of the Irish Carboniferous seas the varying plans of whorl structure exemplified in their shells. The present species adds another to this category, and demonstrates once more the richness of the marine fauna in this extreme western extension of the European Carboniferous rocks.

Besides the specimen here figured, there is one, less perfect, in the Museum of Science and Art, Dublin, from the same locality. Both have been recently collected.

Locality.—Little Island, near Cork.

Genus Aipoceras (see *ante*, p. 116).

Aipoceras? Hainesianum, sp. nov. Plate XXXV, figs. 2 *a*, *b*.

Description.—Shell composed of about one and a half to two very rapidly enlarging incontiguous volutions. Both the dorsal and ventral areas are considerably flattened through rock pressure, the crushing having come in a direction oblique to the longitudinal axis of the shell. The cross-section is transversely oval, the ratio of the two diameters being as 10 : 14 in the younger part of the shell, where it has been less affected by distortion. The periphery is broadly expanded; normally it probably presented a broad, low arch when seen in profile. The sides are narrowly rounded, and merge into the broad dorsal area, which is slightly convex in the median zone, a faint ridge bounding this central area on either side. The outline of the aperture is imperfect, only interrupted portions of it remaining. No trace of a sinus is seen in the peripheral area, but dorsally it appears to have had a broad and shallow sinus (fig. 2 *b*).

The whole of the septate region of the shell is filled with crystalline calcite, which has destroyed every trace of the septa and siphuncle. The surface of the shell is perfectly smooth.

Remarks.—My attention was originally drawn to this species by my friend Mr. Joseph Wright, F.G.S., of Belfast, to whose collection it now belongs, and who kindly lent it to me for examination. It was formerly in the collection of Dr. Haines, of Cork, whose gatherings in the neighbourhood of that city supplied some of the material used by M'Coy in his 'Synopsis.' The specimen described is unique.

Affinities.—The evolute condition of the whorls in this species has suggested the view of its affinities expressed in the doubtful reference to *Aipoceras*.

This uncertainty is caused by the fact that the whorls in the individual here

described are wider than high, while in *Aipoceras* (see p. 116) the reverse of this is the case. Its relationship, therefore, taking this feature into account, would lean rather towards *Solenocheilus* than *Aipoceras*, and the non-contiguity of the whorls may, when all is considered, be of less importance than their general conformation. The question must rest in uncertainty for the present.

Locality.—Near Cork.

Incertæ sedis.

A specimen belonging to the family Solenocheilidæ, but too imperfect for specific identification, is interesting from its exhibiting what *appears to be* a portion of the outer test, which is ornamented with very prominent, transverse, rugose lines. The general form of the shell is very similar to that of *Asymptoceras crassilabrum*, and this resemblance is particularly observable in the broad, slightly depressed periphery; the septa also, so far as they can be made out, agree with that species. The margin of the aperture is not preserved, a considerable part of the body-chamber having been broken off, thus destroying the evidence which might have established its identity with *A. crassilabrum*.

This is the specimen referred to by M'Coy[1] under the name of "*Nautilus dorsalis* (var. γ), Phill.," as being, at the time he wrote, in the collection of the Royal Dublin Society. It now forms part of the general collection of fossils in the Dublin Museum of Science and Art, and is labelled "Kildare." It seems to have been more nearly perfect when M'Coy described it, as he says "mouth nearly circular, receiving the preceding whorl at its ventral [= dorsal] margin." The rugose surface is referred to in his description, and this feature has been the means of identifying the specimen.

Sub-order—AMMONOIDEA.

Family—GLYPHIOCERATIDÆ.

Genus Brancoceras, *Hyatt* (not *Steinmann*), 1883 (emend. Holzapfel, 1889).

Brancoceras ornatissimum, *L. G. de Koninck*, sp. Plate XXXVII, figs. 1 *a*—*c*.

1881. Goniatites ornatissimus, *L. G. de Koninck*. Sur quelques céphalopodes nouveaux du calcaire carbonifère de l'Irlande. Ann. Soc. géol. de Belg., tom. ix, Mémoires, p. 53, pl. vi, figs. 4, 5.

1899. Brancoceras ornatissimum, *G. C. Crick*. Ann. and Mag. Nat. Hist., ser. 7, vol. iii, p. 453.

[1] 'Synops. Carb. Foss. Ireland,' 1844, p. 23.

Description.—Shell discoidal, compressed, with closed umbilicus; greatest thickness at about one-fourth of the height of the whorl from the umbilicus, about seven-tenths of the diameter of the shell; height of outer whorl about three-fifths of the diameter of the shell. Number of whorls unknown; inclusion complete. Sides very slightly convex, merging in the narrowly rounded and somewhat truncated periphery. Umbilicus closed with a callus, which extends to the centre of a shallow funnel-shaped depression. Whorls subcordate in cross-section. Body-chamber unknown, the septate portion alone being present in the sole individual found.

The septation is clearly exhibited, not only by the removal of the test, but also, owing to a fortunate transverse fracture, the greater part of a septum is exposed, thus giving an interior view, which shows the digitate form of the lobes and the cavities left between them (Pl. XXXVII, fig. 1 *b*).

The ornamentation is well marked and very elegant; it consists of distinct raised lines or fine ribs, separated by spaces which are a little wider than the latter. The ribs are from about ·75 to 1 mm. apart. Proceeding from the umbilicus they describe a wide-spread, forwardly directed curve, which merges in a greatly narrowed and backwardly directed sinus upon the periphery, indicating a deeply indented hyponomic sinus. The siphuncle is seen in section in the centre of the peripheral lobe, where it has a diameter of 2 mm.

Dimensions.

	Type specimen in Museum of Science and Art, Dublin.
Diameter of shell . . .	68 mm.
Height of outer whorl (dorso-ventral) .	41·5 „
„ above preceding whorl . .	23 „
Thickness at umbilical margin . .	46 „

Affinities.—Among the species belonging to this genus hitherto described there is none that can be strictly compared with the present one.

The Belgian Carboniferous species, *Brancoceras rotatorium*, de Kon.,[1] sp., resembles the latter in its rather depressed form and closed umbilicus, but the sutures differ in a marked degree. As de Koninck's species is only represented by an internal cast, no comparison can be made of the ornaments of the two species.

Remarks.—This beautiful form, the only one known to occur in the British Isles, is represented by the specimen which is the subject of the above description. Its true affinities had not been recognised until Mr. Crick, in looking over the small collection of Goniatites in the Geological Survey Collection (Dublin Museum of

[1] "Faune Calc. Carb. Belg.," 1880 ('Ann. Mus. Roy. d'Hist. Nat. Belg.,' tom. ii), pt. ii, p. 94, pl. xlvii, fig. 12.

Science and Art), found that not only was it the type of de Koninck's *Goniatites ornatissimus*, but that it belonged to the well-marked group of *Brancoceras* of Hyatt. The specimen had up to that time borne the name of "*Goniatites sphæricus*, var. *crenistria*," but with this species, it need scarcely be said, it has no features in common. It should be stated that the locality given by de Koninck (who must have got his information from an Irish source) for the present species—Tomdeelys, county of Limerick—does not agree with the one registered by the Geological Survey of Ireland, here accepted as authoritative.

Locality.—Glenbane East, county of Limerick.

Genus Pericyclus, *von Mojsisovics*, 1882 (emend. Hyatt, 1883; Holzapfel, 1889).

Pericyclus funatus, *J. Sowerby*, sp. Plate XXXVIII, fig. 5; Plate XXXIX, figs. 1 *a*, *b*.

1813. Ellipsolithes funatus, *J. Sowerby*. Min. Conch., vol. i, p. 81, pl. xxxii.
1822. Ammonellipsites funatus, *J. Parkinson*. Introd. Foss. Org. Rem., pp. 164 and 233.
1828. Nautilus funatus, *J. Fleming*. British Animals, p. 32.
1843. Goniatites funatus, *L. G. de Koninck*, in J. J. d'Omalius, Précis élém. géol., p. 515.
— Nautilus funatus, *J. Morris*. Cat. Brit. Foss., p. 182.
1844. Ammonites princeps (pars), *L. G. de Koninck*. Descrip. Anim. Foss. Terr. Carb. Belg., p. 579 (excl. figs.).
1848. Goniatites princeps (pars), *H. G. Bronn*. Gesch. d. Natur., vol. iii, p. 543.
1888. — funatus, *R. Etheridge*. Brit. Foss., vol. i, Palæozoic, p. 311.
1897. Pericyclus funatus, *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 147.

Description.—Shell of moderate size, subdiscoidal, widely umbilicated; greatest thickness at the umbilical margin; height of outer whorl probably about one-third of the diameter of the shell. Whorls four or five; inclusion about one-half; umbilicus not very deep, nearly one-half of the diameter of the shell in width, with subangular margin. Whorl reniform in section, much wider than high; considerably indented by the preceding whorl; periphery broadly convex and continuous with the sides; inner margin narrow, well defined, steep.

Body-chamber, chambers, and suture-line not seen. Ornamentation consisting of strong, rounded, transverse ribs, as in *P. fasciculatus*, which bifurcate frequently in the young shell, apparently more rarely in the adult. The spaces between the ribs are a little wider than the ribs themselves. Constrictions occur apparently irregularly and at long intervals apart; these are bounded anteriorly by a somewhat stronger rib, upon which a conspicuous node is developed at the umbilical margin. There is no trace of the sharp raised lines which form such a

marked feature in the ornamentation of *P. fasciculatus*. The ribs are almost direct upon the sides of the shell, and form a broad and shallow sinus upon the periphery.

Dimensions.

	Specimen in Museum, Trinity College, Dublin.
Diameter of shell (elliptical by rock pressure)	78 mm.
„ umbilicus (suture to suture of the longer diameter)	36 „
Diameter of umbilicus (of the shorter diameter)	30 „
Thickness at umbilical margin	36 „

Affinities.—A comparison between this species and *P. fasciculatus* is made under the description of the latter (see below). From *P. plicatilis*, de Kon., it is easily distinguished by its more compressed shape, its wider and much shallower umbilicus, and its much coarser ribbing.

Remarks.—Only three specimens of this species are known to me, one of which is the type specimen in the British Museum ("Sowerby Collection"), unfortunately very imperfect (Pl. XXXVIII, fig. 5); another and much better specimen of about the same size contained in the museum of Trinity College, Dublin; and the third a young shell (cast) belonging to Mr. Joseph Wright, F.G.S., of Belfast. All three were obtained in the neighbourhood of Cork, and all are distorted in a similar manner. The pressure causing the distortion has operated from above in a direction oblique to the plane of the umbilicus such that the peripheral area, instead of being at right angles to that plane, as it would be normally, presents an angle of nearly 45° to it, as the result of this severe crushing.

The Trinity College specimen, mentioned above, was kindly lent to me by Professor J. Joly, F.R.S.

Localities.—"Blackrock range, south-east of Cork" (Sowerby's type in the British Museum); "Cork" (Trinity College specimen); "near Cork" (Mr. Wright's specimen, formerly in the collection of Dr. Haines, of Cork).

PERICYCLUS FASCICULATUS, *F. M'Coy*, sp. Plate XXXVII, figs. 2—6.

1844. NAUTILUS (TEMNOCHEILUS) FURCATUS, *F. M'Coy*. Synops. Carb. Foss. Ireland, p. 21, pl. iv, fig. 13.

— GONIATITES FASCICULATUS, *F. M'Coy*. Synops. Carb. Foss. Ireland, p. 13, pl. ii, fig. 8.

1850. AGANIDES SUBFURCATUS, *A. d'Orbigny*. Prod. de Paléont. stratigr., vol. i, p. 115.

1850. Aganides fasciculatus, *A. d'Orbigny*. Prod. de Paléont. stratigr., vol. i, p. 116.
1852. Ammonites Listeri (pars), *C. G. Giebel*. Fauna der Vorwelt, vol. iii, p. 476.
1854. Goniatites furcatus, *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 303.
— — fasciculatus, *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 303.
1855–57. Temnocheilus furcatus, *J. Kelly*. Journ. Geol. Soc. Dublin, vol. vii, p. 8.
— Goniatites fasciculatus, *J. Kelly*. Journ. Geol. Soc. Dublin, vol. vii, p. 7.
1888. Gastrioceras fasciculatum, *M. Tzwetaev*. Mém. Com. géol. St. Pétersbourg, vol. v, No. 3, p. 1.
1897. Pericyclus furcatus, *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 149, fig. 71.
— — fasciculatus, *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 148.

[Not 1841. *Goniatites furcatus*, G. Münster, Beitr. zur Petrefactenkunde, iv, p. 128, pl. xiv, fig. 11.]

Description.—Shell discoidal, somewhat inflated, umbilicated; greatest thickness at the umbilical margin, where it is two-thirds of the diameter of the shell; height of outer whorl two-fifths of the diameter of the shell. Whorls not fewer than five (exact number not ascertainable); inclusion about one-half; umbilicus somewhat less than one-half of the diameter in width, with subangular margin, deep, partly exposing the inner whorls. Whorl reniform in section, about twice as wide as high, not much indented by the preceding whorl; periphery broadly convex, continuous with the convex sides; inner margin rather wide, well defined, very steep.

Body-chamber occupying at least one whorl; aperture not seen. Chambers of moderate depth; suture-line as in Pl. XXXVII, fig. 6. Test ornamented with strong, rounded, transverse ribs, which generally begin to bifurcate at or near the umbilical margin, the bifurcation in some specimens not taking place till the middle of the sides is reached. The ribs form a broad, shallow sinus in crossing the periphery, the sinus sometimes becoming sharply concave in the median line; the intervening concave spaces wider than the ribs. Covering the ribbing and interspaces there are a series of very distinct, sharp, raised lines, disposed irregularly as regards their distance apart; on the ribs about two of the lines occupy the space of 1 mm., but between them the lines are a little more spread out. The tendency of these fine ribs to form bundles is well marked, and made the name "fasciculatus," given by M'Coy to the specimen bearing the test, singularly appropriate.

Affinities.—Though at first sight there is much resemblance between *P. fasciculatus* and *P. furcatus*, yet on a closer inspection it is seen that the differences

far outweigh the resemblances. *P. funatus* is the more slowly tapering shell of the two, and has more numerous whorls, giving a considerably larger umbilical area. Again, though the ribs (at least in casts) are similar in character in the two species, the bundles of finer ribbing in *P. fasciculatus*, only seen when the test is preserved, are entirely absent in *P. funatus*. The two species agree perfectly in the bifurcation of the ribbing, and M'Coy, who seems to have relied upon Sowerby's description, is not accurate when he states that the ribs in *P. funatus* (he calls them "ridges") are "simple, equal, and proceed directly across the shell." Periodic constrictions are present in both species.

From *P. multicostatus*, sp. nov. (p. 139), the present species can be easily distinguished by its less numerous and much coarser ribs and larger umbilicus, and the same features distinguish it still more manifestly from *P. Doohylensis*, which is remarkable for the extreme fineness of its ribbing.

Remarks.—While looking over the choice collection of Carboniferous Limestone fossils in the possession of Mr. Joseph Wright, of Belfast, found chiefly in Cork and places in its vicinity, he drew my attention to a specimen of the so-called *Nautilus* [*Pericyclus*] *furcatus* from Blackrock, in which a portion of the test was preserved, pointing out that the ornamentation was precisely that of the specimen to which M'Coy gave the name "*Goniatites*" *fasciculatus*, in allusion to the bundles of sharp raised lines or fine ribs covering the test.[1] Fortunately M'Coy's type is still extant (Pl. XXXVII, fig. 5), and a comparison of it with Mr. Wright's specimen soon convinced me that that observer was quite correct in his view of the identity of the two so-called species. In most specimens of *P. fasciculatus* collected the test is stripped off and remains in the parent rock, nothing but the cast being left in the collector's hands. This explains M'Coy's omission to notice the finer ribbing, since his specimen was doubtless a cast. It is unfortunately missing from the "Griffith Collection" of the Dublin Museum, in which many of M'Coy's type specimens are contained, but the excellent figure of it in the 'Synopsis' renders it easy of identification.

Though all the specimens of the present species known to me from Cork and its vicinity are more or less distorted, some excessively so, those from other parts of Ireland are of the normal shape. One of these, collected by myself in the Clare quarries, was figured in the 'Catalogue of Fossil Cephalopoda, British Museum,' Part 3, and shows the natural form. It is refigured in the present work (Pl. XXXVII, fig. 2), and may be compared with the larger individual represented on the same plate (fig. 3). Owing to the crushing the latter has been subjected to, its true shape is altered, and the lateral view (fig. 3 *a*) shows some of the peripheral

[1] This name must be retained to the exclusion of *furcatus* (1) because it was the first to be described in the 'Synopsis,' and (2) because it shows the ornaments on the test, whereas the name *furcatus* was applied merely to the cast of the shell.

area (especially on the left-hand side of the figure), none of which would have come into view but for the distortion (cf. fig. 2*b*). On comparing fig. 3*a* with M'Coy's figure ('Synopsis,' pl. iv, fig. 13) it will be seen that the latter is pressed into an elliptical form, the crushing in this case having been exerted in a direction vertical to the plane of the umbilicus and sides of the shell, instead of, as in my shell, oblique to that plane. There is a specimen in Mr. Wright's collection exactly similar to the one represented in M'Coy's figure, both in its size and in the manner of its distortion.

Localities.—Cork, Midleton, Blackrock, in the county of Cork; Glenbane, county of Limerick; Clane, county of Kildare.

Pericyclus Doohylensis, *A. H. Foord and G. C. Crick.* Plate XXXVII, figs. 8 *a*—*c*.

1897. Pericyclus Doohylensis, *A. H. Foord and G. C. Crick.* Cat. Foss. Ceph. British Museum, pt. 3, p. 151, fig. 72.

Description.—The following is the diagnosis of this species given in the 'Catalogue of Fossil Cephalopoda in the British Museum,' from which it will be seen that two forms of the species, one being more compressed than the other, were recognised. No new material has been since acquired.

Shell discoidal, somewhat inflated, umbilicated; greatest thickness near the umbilical margin, from about five-eighths (in the inflated form) to about five-ninths (in the compressed form) of the diameter of the shell; height of outer whorl from about two-fifths (in the inflated form) to about four-ninths (in the compressed form) of the diameter of the shell. Whorls few, but exact number unknown; inclusion about three-fourths; umbilicus deep, exposing the edges of the inner whorls, about one-fourth of the diameter of the shell in width. Whorl semilunate (in the inflated form) or semi-elliptical (in the compressed form) in section, wider than high, indented to about one-quarter of its height by the preceding whorl; periphery broadly convex, sides convex, a little more flattened in the compressed than in the inflated form; inner margin well defined, convex, nearly at right angles to the plane of symmetry.

Body-chamber occupying the whole of the last whorl; aperture with a broad and very shallow peripheral sinus. Suture-line as in Pl. XXXVII, fig. 8 *c*. Test ornamented with numerous very fine, rounded, transverse ribs, separated by rather wider interspaces; the ribs are nearly direct on the lateral area, and form on the periphery a broad, very shallow, forwardly concave sinus; they bifurcate near the umbilical margin at rare intervals. The outer whorl with about four constrictions,

the rib immediately posterior to each of the latter being somewhat stronger than the rest; bifurcation takes place here.

Dimensions.

	British Museum (C. 5934). Inflated form.	Compressed form.
Diameter of shell . .	40 mm. .	45 mm.
„ umbilicus . .	10 „ .	11·5 „
Height of outer whorl . .	16 „ .	20 „
„ „ above preceding whorl . . .	12 „ .	15 „
Thickness at umbilical margin .	24·5 „ .	25 „

Affinities.—The affinities between this species and *P. multicostatus* are pointed out under the description of the latter. It is also nearly related to *P. Kochi*, Holzapfel,[1] but is more widely umbilicated and more compressed. The fineness of its ribbing, added to the periodic constrictions, brings it also into relationship with "*Goniatites*" (*Pericyclus ?*) *impressus*, de Kon., sp.[2] This comparison applies especially to the compressed form of *P. Doohylensis;* another species related to the last named is "*Goniatites*" (*P. ?*) *rirgatus*, de Kon., sp.,[3] which is, however, still more compressed, and has a smaller umbilicus.

Remarks.—This species is apparently greatly restricted in its stratigraphical range in the horizontal sense, being confined, so far as is known, to the two localities cited below. It was collected at Doohyle by the writer in a small slab of decomposing limestone, in a railway cutting on the line of the Limerick and Foynes Railway, not far from Rathkeale. The type specimen is in the British Museum, but others are to be found in the Dublin Museum of Science and Art.

Locality.—Doohyle, near Rathkeale, and Glenbane (compressed form), county of Limerick.

PERICYCLUS MULTICOSTATUS, sp. nov. Plate XXXVII, figs. 7 *a*—*c*.

Description.—Shell discoidal (rendered elliptical by rock pressure), inflated, rather narrowly umbilicated, greatest thickness at the umbilical margin, where the shell expands slightly near the aperture; height of outer whorl, compared with this dimension, as 5 : 7. Whorls few, inclusion fully three-fourths. Umbilicus

[1] 'Paläont. Abhandl.,' Dames und Kayser, vol. v, i, 1889, p. 35, pl. iii, figs. 2—7.

[2] "Faune Calc. Carb. Belg.," 1880 ('Ann. Mus. Roy. d'Hist. Nat. Belg.,' tom. ii), pt. ii, p. 118, pl. xlix, fig. 3.

[3] Loc. cit., p. 118, pl. xlix, fig. 4.

moderately deep, with subangular margin, about two-ninths the diameter of the shell in width, partly exposing the inner whorls. Whorl semilunate in section, considerably wider than high, indented to about one-third of its height by the preceding whorl. Periphery broadly convex, merging into the rather flattened sides; inner (umbilical) margin rather steep, not very well defined.

Body-chamber unknown. Suture-line as in Pl. XXXVII, fig. 7 *c*.

Shell (as indicated on the cast) ornamented with numerous rounded ribs, numbering about five in the space of 1 cm., therefore more numerous than in *P. fasciculatus*, in which there are only four in that space. Interspaces between the ribs somewhat wider than the latter. The ribs bend backwards in passing over the periphery, and form there a shallow median sinus. The fragments of the test that remain are too imperfect to admit of the surface markings being determined. So far as can be discovered in the somewhat unfavourable condition of the cast, bifurcation of the ribs in the adult shell appears to be quite exceptional, but in the young it occurs more frequently, though not as a characteristic feature, as in *P. fasciculatus*. Constrictions separated by wide intervals are seen upon the cast, which would probably be covered by the test when present.

Dimensions.

	Specimen in Mr. Joseph Wright's Collection.
Diameter (longer) of shell (elliptical by rock pressure)	65 mm.
„ „ umbilicus . . .	15 „
Height of outer whorl	32 „
„ „ above preceding whorl .	21 „
Thickness at umbilical margin . . .	35 „

Affinities.—The resemblance between this species and *P. fasciculatus* has already been adverted to; the type of ornamentation is the same; the points in which they differ are sufficiently plain, and they are these: (1) the character of the ribbing, which is much finer in the present species than in *P. fasciculatus*, bifurcation being the exception in the former, and not the rule, as in the latter; (2) the size of the umbilicus, which is smaller in the present species than in *P. fasciculatus*.

From *P. Doohylensis* the present species is distinguished chiefly by its coarser ribbing; it is thus seen that in this feature *P. multicostatus* comes between *P. fasciculatus* and *P. Doohylensis*.

The difference in the septation between *P. multicostatus* and *P. Doohylensis* may be appreciated on comparing the figures of these species on Pl. XXXVII (figs. 7 and 8).

Remarks.—The specimen from which the above description has been drawn up was kindly lent to me by Mr. Joseph Wright.

Locality.—Midleton, county of Cork; Glenbane East, county of Limerick.

PERICYCLUS FOORDI, *G. C. Crick*. Plate XXXVIII, figs. 3 *a*, *b*, 4.

1899. PERICYCLUS FOORDI, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 430, fig. 1.

Description.—The following is Mr. Crick's description of this species, drawn up from the original specimen:—"Shell discoidal, somewhat compressed, and rather widely umbilicated; greatest thickness at the margin of the umbilicus, rather more than two-fifths of the diameter of the shell; height of outer whorl a little more than three-sevenths of the diameter of the shell. Whorls eight or nine; inclusion fully three-fourths; umbilicus rather deep, displaying the umbilical margins of all the inner whorls, about three-tenths of the diameter of the shell in width. Whorl semi-elliptical in cross-section, a little higher than wide, indented to about two-fifths of its height by the preceding whorl; periphery convex, imperfectly defined, sides feebly convex; umbilical zone well defined, sloping towards the umbilicus, and making an obtuse angle with the sides, rather narrow.

"Body-chamber not fully seen, but occupying at least one-half of the outer whorl; aperture not seen, but the peristome (judging by the ornaments and the lines of growth) probably with a feeble lateral crest at about the middle of the lateral area and a deep and wide hyponomic sinus. Depth of chambers not seen; suture-line only imperfectly known.

"Test ornamented with fine, backwardly directed, and somewhat irregularly spaced riblets, which form rather a low crest at about the middle of the lateral area, and a deep and wide hyponomic sinus on the periphery, where some of them are thicker than the rest and somewhat regularly placed. Up to a diameter of about 56 mm. the test is ornamented with rather coarse, regularly placed ribs, which are separated by interspaces a little wider than themselves, and have the same direction as the ornaments of the adult."

Dimensions.

	Cast of type specimen in Museum of Science and Art, Dublin.	Specimen from Cloghran, in British Museum (No. C. 7972).
Diameter of shell	106·5 mm.	122 mm.
„ umbilicus (edge to edge)	42 „	48 „
„ „ (suture to suture)	32 „	40 „
Height of outer whorl	47 „	53 „
Thickness of shell at umbilical margin	46 „	52 „

Supplementary Description.—By the acquisition of more nearly complete specimens I am enabled to amplify Mr. Crick's diagnosis as follows:—(1) The

suture-line has been artificially worked out in a young shell, with a diameter of 68 mm., from Cloghran,[1] in which it is very clearly shown (Pl. XXXVIII, fig. 4). (2) Another feature worthy of note is a flattening of the peripheral area in the young shell, scarcely observable in the (older) type specimen. This flattening amounts almost to truncation at this stage of growth, but becomes obsolete at a diameter of about 100 mm. In the young shell above referred to it defines the area of the periphery, upon which the ribs are disposed in a remarkably regular manner, as observed by Mr. Crick. (3) Judging by the new material placed at my disposal, I think Mr. Crick's estimate of the number of whorls in this species is somewhat excessive. The original specimen, of which I have a plaster cast before me, is broken across the umbilicus, making it difficult to compute the number of the younger whorls. I should put down the total number of whorls at about five, or six at the utmost.

Affinities.—The subject of the relationship of the present species to *Pericyclus subplicatilis*, Crick, is discussed under the description of the latter (below); it will, therefore, only be necessary here to refer to some other species which it resembles. *P. rotuliformis*, Crick,[2] may be taken first; this species bears at least a general resemblance to *P. Foordi* in form and ornamentation, but as respects the first it is a flatter shell, and as to the second feature the ribbing is stronger, and it possesses, in addition, very strong periodic constrictions which give it the wheel-like aspect that suggested its name. In *P. Bailyi*, Crick,[3] we have a species which, while it has a decided resemblance to the present one in its ornamentation, differs from it in its much more inflated form and relatively larger umbilicus.

Localities.—St. Doulagh's (type specimen) and Cloghran, county of Dublin.

PERICYCLUS SUBPLICATILIS, *G. C. Crick.* Plate XXXVIII, figs. 1 *a*, *b*, 2.

1899. PERICYCLUS SUBPLICATILIS, *G. C. Crick.* Ann. and Mag. Nat. Hist., ser. 7, vol. iii, p. 442, figs. 8, 9.

Description.—Mr. Crick gives the following description of this species:—"Shell discoidal, somewhat compressed, moderately widely umbilicated; greatest thickness almost close to the margin of the umbilicus, about two-fifths of the diameter of the shell; height of outer whorl about two-fifths of the diameter of the shell. Whorls six or seven, inclusion four-fifths; umbilicus rather deep, with subangular margin, exposing the edges of the inner whorls, about three-tenths of the diameter of the shell in width. Whorl semi-elliptical in cross-section, about as high as wide, indented to about one-fifth of its height by the preceding whorl; periphery

[1] Now in the British Museum (No. C. 7973).

[2] 'Ann. Mag. Nat. Hist.,' ser. 7, vol. iii, 1899, p. 434, fig. 3.

[3] Ibid., p. 438, figs. 6, 7.

broadly convex, imperfectly defined; sides feebly convex, somewhat flattened near the umbilical margin; umbilical zone narrow, well defined, nearly perpendicular to the plane of symmetry of the shell.

"Body-chamber occupying the whole of the last whorl; aperture not seen, but, judging by the growth-lines and ornaments, the peristome probably nearly straight on the lateral area, and with a deep and broad hyponomic sinus. Chambers [shallow]; suture-line as in [Pl. XXXVIII, fig. 2].

"Test ornamented with feeble, somewhat inequidistant ribs, which, arising at the umbilical margin, pass thence obliquely backward as far as the margin of the periphery, where they bend somewhat abruptly backward, and form on the periphery a deep and wide hyponomic sinus; on the periphery the ribs become nearly equidistant, fairly coarse, and separated by interspaces of about their own width; the ornaments gradually disappear on the outer whorl, those on the lateral area disappearing first, and the ribs on the periphery at about the middle of the last whorl. The whole surface of the test with very fine growth-lines."

Dimensions.

	Cast of type specimen, in Museum of Science and Art, Dublin.	Specimen from St. Doulagh's, in the Woodwardian Museum, Cambridge.
Diameter of shell	113·5 mm.[1]	120 mm.
„ umbilicus (edge to edge)	40 „	45 „
„ „ (suture to suture)	33 „	37 „
Height of outer whorl	43·5 „	50 „
„ above preceding whorl about	35 „	— „
Thickness of shell at umbilical margin	44 „	43 „

Affinities.—Mr. Crick recognised the close resemblance in the ornamentation of the present species to that of *Goniatites plicatilis*, de Kon.,[2] which undoubtedly exists, but the two species differ widely in form. *P. plicatilis*[3] has a much more inflated and thicker shell than *P. subplicatilis*, and the umbilicus is more cavernous in form and has steeper sides than the latter. More complete material has convinced me that in the aggregate of characters *P. Foordi* is the most nearly

[1] This specimen has been broken across and the fissure filled with calcite, so that the diameter of the shell and the height of the last whorl appear to be greater than they really are; the diameter appears to be 122 mm., and the height of the outer whorl 55·5 mm. (Foot-note in Mr. Crick's description of this species, *loc. cit.*, p. 444,—to which may be added that the interposed vein of calcite referred to, by adding to its length, gives the shell an elliptical shape.)

[2] "Sur quelques Céphalopodes nouveaux du calcaire carbonifère de l'Irlande," 'Ann. Soc. géol. de Belgique,' vol. ix, Mémoires, 1881, p. 55, pl. v, figs. 3, 4.

[3] This species will be described and figured later on in this Monograph.

related species to *P. subplicatilis*. I have found, in fact, no inconsiderable difficulty in distinguishing the two, in spite of Mr. Crick's careful diagnosis of them; this difficulty arises partly from the imperfection of the specimens available for description when he wrote, and partly from the fact that there are no specimens of the young shell of *P. subplicatilis* to compare with that of *P. Foordi*, which shows it exposed by the breaking away of the outer whorl. There is good reason for supposing, however, that the young shell in *P. subplicatilis* was much more compressed in form than that of *P. Foordi*, which is remarkable at this stage of growth for the breadth of its whorls compared with their height—a feature which is not maintained in the adult shell. On a comparison of the ornamentation of the two species it is seen that in *P. Foordi* the ribbing when crossing the periphery makes a broader median sinus than that of *P. subplicatilis*, and this is found to be due to the considerably greater breadth of the periphery in the former species, perhaps the most easily distinguishable feature when an appeal has to be made solely to external characters.

When the sutures are compared it will be observed that there are not wanting distinctive marks whereby the differences between the two species are further accentuated. These consist (1) in the greater proximity of the sutures, indicating shallower chambers in *P. Foordi;* (2) in the disposition of the lateral in relation to the peripheral lobe in that species when contrasted with *P. subplicatilis*.

Remarks.—This species is rather plentiful at St. Doulagh's, though the specimens hitherto collected there are all more or less imperfectly preserved, and some are in a crushed condition.

I must express my great indebtedness to the authorities of the Woodwardian Museum, Cambridge, represented by Mr. F. R. Cowper Reid, M.A., F.G.S., who most kindly sent me several interesting specimens obtained at St. Doulagh's, one of which is figured on Pl. XXXVIII. By the loan of these specimens I have been much assisted in completing the description of the present species.

Locality.—St. Doulagh's, county of Dublin.

Pericyclus trapezoidalis, *G. C. Crick*. Plate XXXIX, figs. 2 *a*—*d*.

1899. Pericyclus trapezoidalis, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 432, fig. 2.

Description.—The original diagnosis runs as follows:—"Discoidal, flattened, rather widely umbilicated; greatest thickness at the margin of the umbilicus, nearly four-elevenths of the diameter of the shell; height of outer whorl about four-elevenths of the diameter of the shell. Whorls fairly numerous (exact number not known); inclusion rather more than one-half; umbilicus shallow, displaying

the edges of all the inner whorls, about three-eighths of the diameter of the shell in width, with subangular margin and nearly vertical sides. Whorl subtrapezoidal in cross-section, about as high as wide; indented to about one-fourth of its height by the preceding whorl; periphery narrowly convex, imperfectly defined; sides feebly convex, a little flattened near the umbilicus, and becoming more flattened and convergent on the body-chamber; umbilical zone well defined, narrow, almost perpendicular to the plane of symmetry of the shell. Body-chamber occupying nearly a complete whorl; aperture not seen, but the peristome (judging by the lines of growth) probably with a broad, feeble lateral crest and a fairly deep hyponomic sinus. Depth of chambers not seen; suture-line only imperfectly seen. Test ornamented with narrow, prominent ribs, which pass obliquely backward from the umbilical margin, cross the lateral area in a feeble anteriorly convex curve, and form on the periphery a fairly deep and wide hyponomic sinus; interspaces flat, nearly twice as wide as the ribs; the whole surface of the ribs and interspaces (when well preserved) with fine, close-set lines of growth, especially on the body-chamber. The outer whorl with numerous (nine or ten) constrictions, following the course of the ornaments of the test. 'Wrinkle-layer' composed of fine, regular, close-set longitudinal lines."

Dimensions.

	Unique specimen in Museum of Science and Art, Dublin.
Diameter of shell	141 mm.
„ umbilicus (suture to suture) . .	49 „
„ „ (edge to edge) . . .	53 „
Height of outer whorl	51 „
„ above preceding whorl (about) . . .	30 „
Thickness of outer whorl	50 „

Supplementary Description.—Crossing the ribs and interspaces nearly at a right angle, and thus running in accordance with the curvature of the whorls, are a series of fine raised lines which may easily be seen in a favourable light by the naked eye. On examining the surface of the test with a low magnifying power there is a decided appearance of these lines having formed nodes in crossing the ribs, but the condition of preservation makes this point a doubtful one (Pl. XXXIX, fig. 2 *c*).

The highly ornate character of the test in this species will make it easily recognisable should other specimens fall into the hands of collectors.

Owing partly to distortion, partly perhaps to the grinding of the surface in the effort to develop the sutures having been carried too deep, the latter are not satisfactorily shown, but their general plan can very well be seen (Pl. XXXIX, fig. 2 *d*).

It will be noticed in the drawing that the wall of the siphuncular neck has been cut through, exposing it as a short open tube.

I think it would be a great advantage if authors were to display, whenever this is possible, more than one suture-line, and thus show the distance separating the chambers, as well as the relation of the sutural lines to each other. A suture-line is hardly ever developed without exposing the neighbouring one, either wholly or in part, and the illustrations will be more instructive when they include the latter, even if imperfect.

Affinities.—As one of the distinguishing marks of this species, Mr. Crick points out the "flattened trapezoidal form of the cross-section of its whorls." The ornamentation also is so distinct and characteristic as to be in itself a sufficient means of identification. The only species having any obvious resemblance to the present one is *Pericyclus rotuliformis*, G. C. Crick,[1] but this has much less conspicuous ribbing, while, on the other hand, the constrictions are much stronger than those of *P. trapezoidalis*.

Locality.—Clane, county of Kildare. (Mr. Crick has erroneously given St. Doulagh's as the locality.)

[1] 'Ann. Mag. Nat. Hist.,' ser. 7, vol. iii, p. 435, fig. 3.

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MONOGRAPH

OF THE

CARBONIFEROUS CEPHALOPODA

OF

IRELAND.

BY

ARTHUR H. FOORD, Ph.D. (Münch.), F.G.S.

PART V.

CONTAINING THE FAMILIES

GLYPHIOCERATIDÆ (concluded) AND PROLECANITIDÆ,

WITH TITLE-PAGE AND INDEX,

Pages 147—234: Plates XL—XLIX.

LONDON:

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PERICYCLUS BAILYI, *G. C. Crick*. Plate XL, figs. 1—3.

1899. PERICYCLUS BAILYI, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 438, fig. 6.

Description.—Shell discoidal, somewhat compressed, and rather widely umbilicated; greatest thickness close to the umbilical margin, about four-ninths of the diameter of the shell, height of outer whorl about three-sevenths of that diameter. Whorls possibly six or seven, but in default of perfect adult specimens the number must for the present remain doubtful. Inclusion fully three-fourths. Umbilicus about four-elevenths of the diameter of the shell in width, very deep, exposing all the inner whorls, the margin subangular, sloping inwards, steep. Whorl semi-elliptical in cross-section, slightly wider than high, indented to about three-eighths of its height by the preceding whorl; sides very slightly convex, merging in the rounded periphery.

Body-chamber occupying the whole of the last whorl.

Suture-line as in Pl. XL, fig. 3.

Test ornamented with fairly regular, not very prominent ribs, which are stronger in the young shell than in the adult, in which they become almost obsolete; they form a gentle, backwardly directed curve on the sides of the shell, and are sharply bent backwards upon the periphery. Constrictions appear at intervals, about six being counted in a whorl; their direction corresponds exactly with that of the ribs.

Dimensions.

	Type specimen in the British Museum (No. C. 298).	Specimen from St. Doulagh's, in the Woodwardian Museum, Cambridge (No. 439).
Diameter of shell (body-chamber, incomplete in Cambridge specimen)	97 mm.	55 mm.
„ umbilicus (edge to edge)	35 „	20 „
„ „ (suture to suture)	30 „	17 „
Height of outer whorl	41 „	24 „
„ above preceding whorl (about)	26 „	— „
Thickness at umbilical margin (about)	44 „	26 „

Affinities.—The relations of this species to *Pericyclus Foordi* and to *P. rotuliformis* are referred to under the descriptions of these species.[1] The great depth of the umbilicus and the comparative feebleness of the ribbing, together with the rounded form of the periphery, are its distinguishing features.

Remarks.—As regards the form of the shell and the character of the ornaments,

[1] *P. Foordi*, p. 141; *P. rotuliformis*, p. 148.

the following species, it will be observed, group themselves very naturally together, viz. *Pericyclus Foordi*, *P. subplicatilis*, *P. rotuliformis*, and *P. Bailyi*. As might be anticipated, the young or smaller shells in this group are difficult to discriminate, and, unfortunately, a large gradational series of individuals, so much to be desired among fossils, both on taxonomic and biological grounds, is here wanting. So far, however, as the material indicates, the two forms figured on Pl. XL seem to be quite distinct, the main feature (one which does not appear so striking in the figures as in reality) consisting in the more compressed shape of *P. rotuliformis*, as compared with that of *P. Bailyi*. The ribbing also is seen to be more scanty in the former than it is in the latter.

Locality.—St. Doulagh's, county of Dublin.

Pericyclus rotuliformis, *G. C. Crick*. Plate XL, figs. 4—7.

1899. Pericyclus rotuliformis, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 434, fig. 3.

Description.—Shell discoidal, rather compressed, somewhat widely umbilicated; greatest thickness at the umbilical margin, about three-eighths of the diameter of the shell; height of outer whorl in about the same ratio to that diameter. Whorls not less than four and a half, but possibly exceeding that number, the absence of the body-chamber in all the specimens that have come under my notice making an exact computation unattainable. Inclusion two-thirds. Umbilicus of moderate depth, about three-tenths of the diameter of the shell in width, exposing the inner whorls; the sides slightly sloping, not very deep, with subangular margins. Whorls subcordate in cross-section, very slightly higher than wide, the difference between the two dimensions being scarcely appreciable, as will be seen in the table given farther on. The indentation of the preceding whorl amounts to about one-third of the height of the last one. Sides very slightly convex, merging in the narrowly rounded periphery. Umbilical zone (judging from natural casts only) fairly well defined, sloping towards the centre of the umbilicus, thus making an obtuse angle with the sides. Body-chamber occupying rather more than an entire whorl. The suture-line of this species (Pl. XL, fig. 7) is here figured for the first time.

Test (judging by the fragments of it preserved) ornamented with feeble ribbing, which appears to be rather more conspicuous upon the cast. The ribs bend rather abruptly backwards upon the sides of the shell, and make a rather narrow and linguiform hyponomic sinus upon the periphery. Periodic constrictions occur at irregular intervals and form very deep grooves upon the cast, but are shallower where the test is present; there are generally about seven of them in the circuit of a whorl, and they form a very conspicuous feature in this species. Their direc-

tion exactly corresponds with that of the ribs. Very fine transverse lines cover the whole of the test, but they are too delicate to leave any impression upon the cast. Beginning with the first whorl and extending to the penultimate one are a series of small but conspicuous nodes or tubercles situated at the edge of the umbilicus; these apparently become obsolete on the last whorl. I have observed them only upon a specimen from which the rock has been entirely removed from the umbilical cavity (Pl. XL, fig. 5).

Dimensions.

	Type specimen in Museum of Science and Art, Dublin.	Another specimen in Museum of Science and Art, Dublin.
Diameter of shell	81 mm.	73 mm.
„ umbilicus (edge to edge)	29 „	30 „
„ „ (suture to suture)	23 „	about 25 „
Height of outer whorl	32·5 „	28 „
„ above preceding whorl	22 „	about 22 „
Thickness at umbilical margin	32 „	33 „

Affinities.—Its narrowly rounded periphery, shallower umbilicus, and strong constrictions distinguish this species from *Pericyclus Bailyi*, Crick (p. 147), which it superficially resembles. A rather coarsely ribbed, thick form, which may be the young of *P. Foordi*, Crick,[1] is by these characters equally excluded from the present species.[2] The deep constrictions in the latter cause it to be easily recognised in all stages of growth; these constrictions are somewhat deeper upon the cast, but among numerous specimens collected only fragments of the test have been preserved, so that this has not in any case presented a difficulty.

Remarks.—Among the specimens of *P. rotuliformis* submitted by the writer to Mr. Crick,[3] he describes one which is somewhat more inflated than the type specimen from which his description was chiefly drawn up. In all other respects it agrees with the latter. The dimensions of both are given above.

The smaller of the specimens figured (Pl. XL, fig. 5) belongs to the Woodwardian Museum, Cambridge, and was kindly lent to me by the museum authorities, along with other specimens.

Localities.—St. Doulagh's, county of Dublin; Glenbane, county of Limerick.

[1] This monograph ('Mem. Palæont. Soc.,' vol. for 1901), p. 141.

[2] This monograph, p. 142.

[3] 'Ann. Mag. Nat. Hist.,' ser. 7, vol. iii, 1899, p. 436.

PERICYCLUS PLICATILIS, *L. G. de Koninck*, sp. Plate XLI, figs. 2 *a*—*d*.

1881. GONIATITES PLICATILIS, *L. G. de Koninck*. Sur quelques céphalopodes nouveaux du calcaire carbonifère de l'Irlande. Ann. Soc. géol. de Belgique, tom. ix, 1881–82 (Mémoires), pp. 50—60, pl. v, figs. 3, 4 (not pl. vi, as erroneously referred to).

1899. PERICYCLUS PLICATILIS, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 441.

Description.—Shell subglobose, rather widely umbilicated; greatest thickness at the umbilical margin, about two-thirds of the diameter of the shell; height of outer whorl about two-fifths of the diameter of the shell. Number of whorls not ascertainable; inclusion almost complete; umbilicus deep, about one-third of the diameter of the shell in width, exposing the angular edges of the inner whorls. Whorl very distinctly semilunate in cross-section, much wider than high; indented to about two-thirds of its height by the preceding whorl. Periphery broadly arched, imperfectly defined, merging into the slightly convex sides. Umbilical zone well defined, rather wide, nearly perpendicular to the plane of symmetry of the shell with a little inclination towards the centre of the umbilicus.

Body-chamber occupying at least the whole of the last whorl. Aperture not preserved, but from the direction of the ribbing it would appear to have had a broad and moderately deep hyponomic sinus.

Suture-line as in Pl. XLI, fig. 2 *d*.

Test ornamented with slender but prominent ribs, which, arching forwards upon the sides of the shell, bend somewhat abruptly backwards and form upon the periphery a broad and moderately deep hyponomic sinus; the interspaces are somewhat wider than the ribs; the whole surface of the test is covered with fine lines of growth.

Dimensions.

	Type specimen in Museum of Science and Art, Dublin (Geological Survey Collection).
Diameter of shell (about)	85 mm.
,, umbilicus (edge to edge)	38 ,,
,, ,, (suture to suture)	30 ,,
Height of outer whorl (about)	34 ,,
,, above preceding whorl	21 ,,
Thickness at umbilical margin (about)	60 ,,

Remarks.—De Koninck's measurements of this species are:—Longitudinal

diameter, 85 mm.; transverse diameter, 58 mm.; diameter of umbilicus, 30 mm.; median height of the aperture, 21 mm. These agree very closely with the measurements given above, though the specimen appears to have been fractured a little after it had left de Koninck's hands. His drawing represents it as undistorted, this circumstance probably causing its identity to be afterwards overlooked, for it has been labelled "*Goniatites Wrightii*," as if it were an undescribed species; this name exists only on the tablet.

Affinities.—This species has been mistaken for *Pericyclus fasciculatus* (= *P. furcatus*), M'Coy, from which it is easily distinguished by the larger number and less prominent character of its ribs, and the absence of bifurcation in them. It is also a much more inflated shell; this character, together with its deep umbilicus, distinguishes it also from *P. subplicatilis*, Crick. *P. funatus*, J. Sowerby, may be an allied form, but it has more numerous whorls and is a more compressed shell than *P. plicatilis*; the plications also are much coarser in the former species. *Pericyclus plicatilis* differs, according to Mr. Crick, from *P. Hauchecorni*, Holzapfel,[1] in its coarser ornaments and much more inflated whorls.

Locality.—Kilmacat, county of Limerick (erroneously written "Kilmacan" by de Koninck).

PERICYCLUS? CLANENSIS, *G. C. Crick*. Plate XLI, figs. 1 *a*—*c*.

1888. PERICYCLUS CLANENSIS, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 437, fig. 4.

Description.—Shell discoid, rather compressed, especially laterally, somewhat narrowly umbilicated; greatest thickness near the edge of the umbilical margin, rather more than four-elevenths of the diameter of the shell. Whorls few; their number not ascertainable in the only specimen at present known; inclusion nearly two-thirds; umbilicus shallow, rather more than one-fourth of the diameter of the shell in width, with narrowly rounded margin. Whorl semi-elliptical in cross-section, somewhat higher than wide; indented to rather more than one-third of its height by the preceding whorl. Periphery convex, imperfectly defined; sides slightly convex, somewhat flattened near the umbilicus; umbilical zone extremely narrow, sloping a little towards the umbilicus. Body-chamber slightly exceeding the last whorl in length; aperture not present, but, judging by the lines of growth, there was probably a moderately prominent lateral crest and a broad and rather deep hyponomic sinus. Chambers (near the base of the body-chamber where alone they

[1] "Die Cephalopoden-führenden Kalke des unteren Carbon von Erdbach-Breitscheid bei Herborn." ('Pal. Abhandl., Dames und Kayser'), Bd. v, Heft 1, 1889, p. 36, pl. ii, figs. 8—11 (especially figs. 11, 11 *a*).

are seen) shallow; suture-line as in Pl. XLI, fig. 1*c*, but the apex of the lateral lobe is not represented sufficiently acute. Test ornamented with coarse and rather irregular ribbing or lines of growth, which, on leaving the umbilical margin, bend backwards across the sides of the shell, and in passing over the periphery constitute the broad and rather deep sinus already referred to. The lines or ribs here described (they are somewhat obscure) are seen more distinctly upon the cast than upon the test, only fragments of which are preserved. Some faint constrictions are seen upon the cast of the body-chamber conforming in their direction to the lines of growth.

Dimensions.

	Type specimen in Museum of Science and Art, Dublin.
Diameter of shell	120 mm.
„ umbilicus on the cast (edge to edge) .	33·5 „
„ „ „ (suture to suture)	31 „
Height of outer whorl . . .	52 „
„ above preceding whorl . .	33·5 „
Thickness at umbilical margin (about) . .	44 „

Affinities.—The comparative width of the shallow umbilicus and the compressed form of the shell are features which bring this species into relationship with *Pericyclus Leesoni* (p. 153), but the latter has a much narrower periphery, and is on the whole a flatter and more slender shell than *P. Clanensis*.

Remarks.—The present species is founded upon a single specimen contained in the Museum of Science and Art, Dublin, and was originally labelled "*Goniatites Brownii*," M'Coy,[1] but it bears very little resemblance to that species.

Mr. Crick[2] referred the present species to *Pericyclus*, but its claim to belong to that genus must be held to be somewhat doubtful, as the surface of the test is badly preserved, and only fragments of it remain. The chief diagnostic character of *Pericyclus*[3] is the presence of "strong, direct, transverse ribs."

The late Professor Hyatt distinguished *Pericyclus* chiefly by its suture-line, in which he recognised a spatulate external saddle, and an additional broad, angular, lateral lobe, making two lateral lobes instead of one. This peculiarity is, I believe, met with only in *P. virgatus*, de Kon.; it is figured by Holzapfel.[4] The latter species, along with *P. princeps*, de Kon., formed Mojsisovics' genus *Pericyclus*. Great variability is observable on comparing together the suture-line in different species of *Pericyclus*, and it was upon this ground that Holzapfel urged that the

[1] 'Synops. Carb. Foss. Ireland,' 1844, p. 12, pl. iv, fig. 17.

[2] 'Ann. Mag. Nat. Hist.,' ser. 7, vol. iii, 1899, p. 436.

[3] 'Cat. Foss. Ceph. Brit. Mus.,' pt. 3, 1897, pp. 143, 144, figs. 68, 69 (respectively *P. princeps* and *P. virgatus*—suture-line).

[4] 'Palæont. Abhandl.,' Dames und Kayser, vol. v, I, p. 34, pl. iii.

suture-line must not be relied upon too much for diagnostic purposes, but rather the ornamentation of the shell, and also the absence of a sinus, lateral or peripheral, in the border of the aperture. If Holzapfel be correct this latter feature casts a further doubt upon the generic position assigned to this species, which clearly has a peripheral sinus.

Locality.—County of Kildare (exact locality unrecorded).

PERICYCLUS? LEESONI, *G. C. Crick*, sp. Plate XLVI, figs. 6 *a*—*c*.

1899. PROLECANITES LEESONI, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 451, figs. 15 *a*, *b*.

Description.—Shell discoid, compressed, umbilicated; the greatest thickness at the umbilical margin, about one-third of the diameter of the shell; height of the outer whorl about four-ninths of the same. Number of whorls not ascertainable; inclusion nearly three-fourths; umbilicus rather shallow, with steeply sloping sides and subangular margin (on the cast), its width about two-sevenths of the diameter of the shell. Whorl subsagittate in section, the width nearly three-fourths of the height, indented to about two-sevenths of its height by the preceding whorl; periphery narrow, somewhat flattened, especially towards the aperture, obscurely defined; sides very slightly convex; umbilical zone narrow, well defined, sloping towards the centre of the umbilicus. Body-chamber probably occupying at least a complete whorl; aperture not seen. Test so much eroded as to leave on the sides only obscure traces of ornamentation, but the indications are strongly in favour of the shell having been transversely costated; remains of ribbing are obscurely visible on the sides and more plainly upon the periphery where the test is preserved in places, their direction here indicating a rather deep and narrow hyponomic sinus. As far as can be judged the ribbing seems to have been only slightly curved upon the sides. Two shallow constrictions are present upon the cast, one near the commencement of the body-chamber, the other more posteriorly situated; their direction conforms to that of the ribbing.

Dimensions.

	Type specimen in the Museum of Science and Art, Dublin (Geological Survey Collection, No. C. 748).
Diameter of shell	90 mm.
„ umbilicus (edge to edge)	27 „
„ „ (suture to suture)	24 „
Height of outer whorl	40·5 „
„ above preceding whorl	28 „
Thickness at umbilical margin	29·5 „

Remarks.—Since Mr. Crick described this fossil I have been enabled to expose a portion of the suture-line (Pl. XLVI, fig. 6 *c*). This shows that the species has no relationship with *Prolecanites*, as assumed by its author, who had of course not seen the suture-line when he wrote his description. The presence of ribbing (which may with strong probability be admitted) and the general character of the suture-line leaves little doubt that this species belongs to *Pericyclus;* its relationship to *P. Clanensis*, G. C. Crick, is pointed out under the description of that species.

Locality.—Glenbane East, county of Limerick.

Genus Glyphioceras, *Hyatt*, 1883 (emend. Holzapfel, 1889).

Sub-genus Sphenoceras,[1] sub-gen. nov.

Glyphioceras (Sphenoceras) sphæricum, *W. Martin*, sp. Plate XLII, figs. 1 *a*, *b*, 2.

1809. Conchyliolithus Nautilites sphæricus, *W. Martin.* Petrificata Derbiensia, p. 15, pl. vii, figs. 3—5.
1814. Ammonites sphæricus, *J. Sowerby.* Min. Conch., vol. i, p. 116, pl. liii, fig. 2.
1825. Goniatites sphæricus, *G. de Haan.* Monogr. Ammon. et Goniat., p. 159.
1828. Orbulita sphærica, *J. Fleming.* History of British Animals, p. 248.
1829. Globites sphæricus, *F. Holl.* Handb. d. Petrefakt., p. 227.
1832. Ammonites carbonarius (pars), *L. von Buch.* Phys. Abhandl. d. k. Akad. d. Wissensch. Berlin for 1830, p. 176, pl. ii, figs. 9, 9^{I}—9^{III} (*not* 9^{IV}).
1836. Goniatites sphæricus, *J. Phillips.* Geology of Yorkshire, pt. 2, p. 234, pl. xix, figs. 4—6.
— Ammonites sphæricus, *W. Buckland.* Geol. and Mineral., vol. ii, p. 61, pl. xl, fig. 3.
1837. — — *H. E. Beyrich.* De Goniatitis in montibus rhenanis occurrentibus, p. 13.
— — — — Beitr. z. Kenntn. d. Verstein. d. rhein. Uebergangsgeb., p. 38.
1842-44 — — *L. G. de Koninck.* Descrip. Anim. Foss. Terr. Carb. Belgique, p. 570, pl. xlix, fig. 6; pl. l, figs. 9, 10.
1843. Goniatites sphæricus, *J. Morris.* Cat. Brit. Foss., p. 180.
1844. — — *F. M'Coy.* Synops. Carb. Foss. Ireland, p. 15.
1846. — — (pars), *F. A. Quenstedt.* Petrefact. Deutschl., Bd. i (Cephalopoden), p. 66, pl. iii, fig. 11 (excl. figs. 10 *a*—*d*).
1848. — — *J. H. Cumming.* Isle of Man, p. 357.

[1] Referring to the wedge-shaped outline of the lobes and saddles. For definition of this sub-genus see Appendix, p. 218.

1848. Goniatites sphæricus, *H. G. Bronn.* Gesch. d. Natur, Bd. iii, p. 544.
1850. Aganides sphæricus (pars), *A. d'Orbigny.* Prod. de Paléont. stratigr., vol. i, p. 15.
1852. Ammonites sphæricus (pars), *C. G. Giebel.* Fauna der Vorwelt, vol. iii, p. 471.
Goniatites sphæricus, *F. A. Quenstedt.* Handb. d. Petrefact., p. 351, pl. xxvi, fig. 25.
1854. — — *J. Morris.* Cat. Brit. Foss., 2nd ed., p. 304.
1855. Aganides sphæricus, *F. M'Coy.* Brit. Pal. Foss., p. 566.
1855–57. Goniatites sphæricus, *J. Kelly.* Journ. Geol. Soc. Dublin, vol. vii, p. 7.
1860. — — *E. d'Eichwald.* Lethæa Rossica, vol. i, p. 1322.
1862. — — *T. Wardle.* In J. Sleigh's History of Ancient Leek, p. 281, pl. i, fig. 3.
1867. — — *H. Trautschold.* Bull. Soc. Imp. Nat. Moscou, vol. xl, No. 3, p. 44, pl. v, fig. 10.
1875. — — *W. H. Baily.* Fig. Charact. Brit. Foss., p. 117, pl. xl, figs. 9 *a*, *b*.
1876. — — *J. Armstrong, J. Young, and D. Robertson.* Cat. Western Scottish Foss., p. 58.
1878. — — *G. A. Lebour.* Geology of Northumberland, p. 68.
1880. — — (pars), *L. G. de Koninck.* Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., tom. v.), pt. 2, p. 97, pl. xlvii, figs. 3—5.
1883. — — *L. G. de Koninck.* Bull. Mus. Roy. d'Hist. Nat. Belg., tom. ii, p. 263.
Glyphioceras sphæricum, *A. Hyatt.* Genera of Fossil Cephalopods; Proceed. Boston Soc. Nat. Hist., vol. xxii, p. 329.
— carbonarium (pars), *A. Hyatt.* Ibid., vol. xxii, p. 329.
1885. Goniatites sphæricus, *F. A. Quenstedt.* Handb. d. Petrefact., 3rd ed., p. 538, pl. xlii, fig. 3.
— — *G. H. Morton.* Proceed. Liverpool Geol. Soc., vol. iv, p. 316: "Carboniferous Limestone and Cefn-y-fedw Sandstone of Flintshire."
1887. — — *D. L. Mallada.* Mem. Com. del Mapa Geologico de España, vol. i, pt. 2, p. 664, pl. iii, figs. 1, 2.
1888. — — *R. Etheridge.* Brit. Foss., vol. i, Palæozoic, p. 312.
1889. Glyphioceras sphæricum, *E. Holzapfel.* Palæont. Abhandl., Dames und Kayser, Bd. v, 1, p. 26.
1890. — — *G. Steinmann und L. Döderlein.* Elemente der Palæontologie, pt. 2, p. 393.
1891. Goniatites (Glyphioceras) sphæricus, *H. Credner.* Elemente der Geologie, p. 459, fig. 277.
1893. Glyphioceras sphæricum, *A. Hyatt.* Carboniferous Cephalopods. Second Paper. Geological Survey of Texas, Fourth Annual Report, 1892, pp. 471, 472.

1895. Goniatites sphæricus, *G. H. Morton*. Proc. Liverpool Nat. Field Club for 1894, p. 23.

— Glyphioceras sphæricum, *F. Bernard*. Éléments de Palćontologie, p. 649, fig. 345 a.

— Goniatites (Glyphioceras) sphæricus, *K. A. v. Zittel*. Grundzüge der Palæontologie, p. 399, fig. 1082.

1897. Glyphioceras sphæricum, *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 157, figs. 73 *a*—*c*.

— — — *James Perrin Smith*. "Development of Glyphioceras and the Phylogeny of the Glyphioceratidæ;" Proceed. California Acad. Sci., ser. 3, Geology, vol. i, pp. 110, 113, 115.

1900. — — *A. Hyatt*. In translation of Karl A. von Zittel's Elements [Grundzüge] of Palæontology, edited by Charles R. Eastman, p. 552, fig. 1133.

1900–1901. Goniatites sphæricus, *G. H. Morton*. "The Carboniferous Limestone of Anglesey," Proc. Liverpool Geol. Soc., p. 52.

Description.—"Shell globular, greatest thickness almost close to the edge of the umbilicus, about three-fourths of the diameter of the shell in the adult, proportionately greater in the young; height of outer whorl about four-ninths of the diameter of the shell. Whorls eight to ten; inclusion almost complete; umbilicus rather small, acute-edged, a little more than one-sixth of the diameter of the shell in width, with steep sides. Whorl semilunate in section, its height about three-fifths of its width; indented to rather more than one-half of its height by the preceding whorl; periphery broadly convex; sides convex, very slightly depressed around the umbilicus in the adult; inner area nearly perpendicular to the plane of symmetry. Body-chamber occupying the whole of the last whorl; aperture not seen. Chambers not very deep, about eighteen in a whorl. [Suture-line as in Pl. XLII, figs. 1 *a*, *b*, 2.] Test with fine spiral striæ, rarely preserved; internal casts with obscure transverse striæ, and at intervals with very shallow constrictions." ('Cat. Foss. Ceph. British Museum,' loc. cit.)

Dimensions.

	Young specimen (cast) from Bantry, in Mr. Joseph Wright's Collection.
Diameter of shell	28 mm.
„ umbilicus	7 „
Height of outer whorl (about) . . .	12 „
Thickness at umbilical margin (about) . .	22 „

The shell attains a diameter of 60 mm. with a thickness of 46 mm.

Affinities.—This species is distinguished from *Glyphioceras striatum*, J. Sow., by its more globose form, and by its suture-line.

Remarks.—This is a common and widely distributed species, as the long list of references to it at the head of the description testifies. It has been found in the British Isles, Belgium, and the Hartz. It is easily recognised by its globular shape, and the suture-line is also characteristic. Casts of it are more frequently met with than specimens having the shell preserved (probably owing to the tenuity of the test); hence the suture-line is generally exposed.

This species, like *G. striatum* (p. 160), appears to be rare in Ireland, and I can only record two localities for it. The specimen from which M'Coy drew up the description in his 'Synopsis' (loc. cit.) belonged apparently to a private collection, as it is contained in a list of species to which the following heading is appended:—"The following fossils are described in my Synopsis, though not contained in the cabinets" [*i. e.* those belonging to Sir R. Griffith's Collection]. The Goniatites enumerated in this list are *G. Browni*, *G. crenistria*, *G. sphæricus*, *G. spiralis*, and *G. vittiger*. No localities are attached to them.

The largest individuals belonging to the present species have been found in Belgium; de Koninck records one having a diameter of 70 mm. and a thickness of 55 mm. as the largest he had met with. M'Coy's specimen ('Synopsis,' loc. cit.) measured 46·5 mm. in diameter and 38 mm. in thickness.

Localities.—Loughshinny, county of Dublin; near Bantry, county of Cork. (The specimen from the former locality is contained in the Dublin Museum of Science and Art—Geological Survey Collection; that from the latter belongs to Mr. Joseph Wright, to whom I am indebted for the loan of it.)

GLYPHIOCERAS (SPHENOCERAS) CRENISTRIA, *J. Phillips*, sp. Plate XLII, fig. 5.

1836.	GONIATITES CRENISTRIA,		*J. Phillips.*	Geology of Yorkshire, pt. 2, p. 234, pl. xix, figs. 7—9.
? 1841.	—	—	—	Pal. Foss. Cornwall, Devon, and W. Somerset, p. 121, pl. l, figs. 234 *a—g*.
? 1843.	—	—	*F. A. Roemer.*	Verstein. Harzgeb., p. 33, pl. ix, figs. 10 *a*, *b*.
—	—	—	*J. Morris.*	Cat. Brit. Foss., p. 180.
1842–44.	AMMONITES STRIATUS (pars),		*L. G. de Koninck.*	Descrip. Anim. Foss. Terr. Carb. Belgique, p. 568.
1848.	GONIATITES CRENISTRIA,		*J. H. Cumming.*	Isle of Man, p. 357.
	—	STRIATUS (pars),	*H. G. Bronn.*	Gesch. d. Natur, vol. iii, p. 545.
1850.	AGANIDES STRIATUS (pars),		*A. d'Orbigny.*	Prod. de Paléont. stratigr., vol. i, p. 115.

1850. Goniatites crenistria, *F. A. Roemer.* Palæont., vol. iii, p. 51, pl. viii, figs. 13 *a—c*; and Beitr. z. geol. Kenntn. nordwestl. Harzgeb., p. 51, pl. viii, figs. 13 *a—c*.

1850–56. — — (pars), *G. and F. Sandberger.* Verstein. rhein. Schichtensyst. Nassau, p. 74.

1852. Ammonites sphæricus (pars), *C. G. Giebel.* Fauna der Vorwelt, vol. iii, p. 471.

— Goniatites crenistria, *F. A. Roemer.* Beitr. zur geol. Kenntn. nordwestl. Harzgeb., pt. 2, p. 93, figs. 29 *a—c*.

1854. — — *J. Morris.* Cat. Brit. Foss., 2nd ed., p. 303.

1855. Aganides sphæricus, var. β, crenistria, *F. M'Coy.* Brit. Pal. Foss., p. 567.

1855–57. Goniatites crenistria, *J. Kelly.* Journ. Geol. Soc. Dublin, vol. vii, p. 7.

1870. — sphæricus, *F. Roemer.* Geol. Oberschlesien, p. 55, pl. vi, fig. 2.

1880. — striatus (pars), *L. G. de Koninck.* Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Palæont., vol. v), pt. 2, p. 101.

1882. crenistria, *C. Barrois.* Mém. Soc. géol. du Nord, vol. ii, No. 1, p. 292, pl. xiv, fig. 1.

1884. Glyphioceras crenistria, *A. Hyatt.* Proc. Boston Soc. Nat. Hist., vol. xxii, p. 329.

1888. Goniatites crenistria, *R. Etheridge.* Brit. Foss., vol. i, Palæozoic, p. 311.

1893. Glyphioceras crenistria, *A. Hyatt.* Carboniferous Cephalopods. Second Paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 471.

1894. — — — "Phylogeny of an Acquired Characteristic," Proceed. Amer. Phil. Soc., vol. xxxii, p. 609.

1895. — — *K. A. von Zittel.* Grundzüge der Palæont., p. 399.

1897. — — *A. H. Foord and G. C. Crick.* Cat. Foss. Ceph. British Mus., pt. 2, p. 160, fig. 76 (suture-line).

— — *James Perrin Smith.* "Development of Glyphioceras and the Phylogeny of the Glyphioceratidæ," Proceed. California Acad. Sci., ser. 3, Geology, vol. i, pp. 110, 113.

1898. — — *G. C. Crick.* Trans. Linn. Soc., ser. 2, vol. vii, p. 106, pl. xx, figs. 15—18.

– — cf. crenistria, *W. Wolterstorff.* Jahrb. d. Königl. Preuss. geol. Landesanst. u. Bergakad.: "Das Untercarbon von Magdeburg-Neustadt und seine Fauna," p. 30, Taf. ii, figs. 7, 8, 18.

1903. Goniatites crenistria, *Jas. Perrin Smith.* "The Carboniferous Ammonoids of America," U.S. Geol. Surv., Mon. xlii (pp. 1—211, 29 plates). Author's Abstract in Geologisches Centralblatt, Bd. iii, No. 13, p. 680.

Description.—"Shell subglobose; greatest thickness in the adult at a short distance from the margin of the umbilicus, in immature specimens at the margin of the umbilicus, about three-fifths of the diameter of the shell; height of outer whorl a little more than one-half of the diameter of the shell. Whorls six or seven; inclusion almost complete; umbilicus small, open, about one-tenth of the diameter of the shell in width. Whorl semi-elliptical in section, rather wider than high; indented to from one-half (in the young) to one-third (in the adult) of its height by the preceding whorl; periphery broadly convex; sides not very convex, rather flattened, the portion around the umbilicus prominent in the adolescent stage, slightly depressed in the adult; inner area imperfectly defined, in the cast almost at right angles to the plane of symmetry. Body-chamber occupying a complete whorl, aperture not seen. Chambers shallow, nineteen or twenty to a whorl. [Suture-line as in Pl. XLII, fig. 5.] Test thin, with fine, crenulated, feebly reticulated, curved, transverse striæ, which form a broad, forwardly concave sinus on the periphery; becoming almost smooth in the adult. Shell attaining a diameter of 66 mm." ('Cat. Foss. Ceph. British Museum,' loc. cit.)

Affinities.—The distinguishing feature of this species is the crenulation of the transverse striæ covering the test. In form it resembles *Glyphioceras striatus*, J. Sow., with which de Koninck has indeed united it, but its suture-line is quite distinct from the latter, and would in itself be a sufficient ground for separating the two species; the umbilicus is also smaller than that of *G. striatus*.

Remarks.—A well-preserved septate specimen, 38 mm. in diameter, with fragments of the test, is contained in the British Museum (Morris Collection, No. 50,183); this specimen is the one figured (Pl. XLII, fig. 5).

Phillips has recorded this species from Queen's County and the county of Fermanagh, as well as from Bolland, and the Isle of Man.

Localities.—Queen's County; county of Fermanagh. (The British Museum specimen cited above is labelled "Ireland" only.)

GLYPHIOCERAS (SPHENOCERAS) STRIATUM, *J. Sowerby*, sp. Plate XLII, figs. 3, 4; Plate XLIII, figs. 2 *a*, *b*.

1749. A beautiful NAUTILITES, *C. Lyttleton*. Phil. Trans., vol. xlv, p. 320, fig. 2.
1814. AMMONITES STRIATUS, *J. Sowerby*. Min. Conch., vol. i, p. 115, pl. liii, fig. 1 (*not* Reinecke, *nor* Münster).
1825. GONIATITES STRIATUS, *G. de Hann*. Monog. Ammon. et Goniat., p. 159.
1828. ORBULITA STRIATA, *J. Fleming*. History of British Animals, p. 248.
1829. GLOBITES STRIATUS, *F. Holl*. Handb. Petrefact., p. 227.
1836. GONIATITES STRIATUS, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 233, pl. xix, figs. 1—3.
– AMMONITES STRIATUS, *W. Buckland*. Geology and Mineralogy (Bridgewater Treatise), vol. ii, p. 60, pl. xl, fig. 2.
1838. — — *L. Agassiz*. In Desor's translation of Sowerby's Mineral Conchology, vol. i, p. 27, pl. xxvi.
1842–44. — — (pars), *L. G. de Koninck*. Descrip. Anim. Foss., p. 568, pl. xlix, figs. 7 *a*—*d*; pl. l, figs. 7 *a*—*c*.
1842. GONIATITES STRIATUS, *G. B. Sowerby*. Conch. Man., p. 309, fig. 480.
1843. — — *J. Morris*. Cat. Brit. Foss., p. 180.
– — — *J. E. Portlock*. Geology of Londonderry, p. 407.
1844. — — *F. M'Coy*. Synops. Carb. Foss. Ireland, p. 16.
1846. — SPHÆRICUS (pars), *F. A. Quenstedt*. Petrefact. Deutschl., vol. i (Cephalopoden), p. 66, pl. iii, figs. 10 *a*—*d* (excl. fig. 11).
1848. — STRIATUS (pars), *H. G. Bronn*. Gesch. der Natur, vol. iii, p. 545.
1850. AGANIDES STRIATUS (pars), *A. d'Orbigny*. Prod. de Paléont. stratigr., vol. i, p. 115.
1852. AMMONITES SPHÆRICUS (pars), *C. G. Giebel*. Fauna der Vorwelt, vol. iii, p. 471.
1854. GONIATITES STRIATUS, *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 304.
1852–54. — SPHÆRICUS (pars), *F. Roemer*, in H. G. Bronn's Lethæa Geogn., 3rd ed., vol. i, pt. 2, p. 517, pl. ii, figs. 17 *a*—*c*.
1855. AGANIDES SPHÆRICUS, var. γ, STRIATUS, *F. M'Coy*. Brit. Pal. Foss., p. 567.
1855–57. GONIATITES STRIATUS, *J. Kelly*. Journ. Geol. Soc. Dublin, vol. vii, p. 7.
1864. — — *J. W. Salter*. Mem. Geol. Surv., Geology of the Country around Oldham, p. 59.
1876. — SPHÆRICUS, *F. Roemer*. Lethæa Palæozoica, pl. xlvi, figs. 11 *a*—*c*.
– — STRIATUS, *J. Armstrong, J. Young, and D. Robertson*. Cat. Western Scottish Foss., p. 59.

1880. Goniatites striatus (pars), *L. G. de Koninck.* Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., vol. v), pt. 2, p. 101, pl. xlvi, figs. 1, 2; pl. xlvii, figs. 1, 2.

1883. — — *L. G. de Koninck.* Bull. Mus. Roy. d'Hist. Nat. Belg., tom. ii, p. 263.

1884. Glyphioceras striatum, *A. Hyatt.* Proc. Boston Soc. Nat. Hist., vol. xxii, p. 329.

1888. Goniatites striatus, *R. Etheridge.* Brit. Foss., vol. i, Palæozoic, p. 313.

1890. Glyphioceras striatum, *G. Steinmann und L. Döderlein.* Elem. der Paläont., p. 393.

1893. — . — *A. Hyatt.* Carboniferous Cephalopods. Second Paper. Geological Survey of Texas, Fourth Annual Report, 1892, p. 471.

1897. — — *A. H. Foord and G. C. Crick.* Cat. Foss. Ceph. British Museum, pt. 3, p. 166, fig. 78 (suture-line).

— — *James Perrin Smith.* "Development of Glyphioceras and the Phylogeny of the Glyphioceratidæ," Proceed. California Acad. Sci., ser. 3, Geology, vol. i, pp. 110, 113.

1899. Goniatites striatus, *James Spencer.* Proceed. Yorkshire Geol. and Polytech. Soc., new ser., vol. xiii, pt. 4, p. 391.

1901. — (sens. str. in Haug) striatus, *Collot.* "Goniatites carbonifères dans le Sahara" (Comptes rendus hebdomadaires des Séances de l'Académie des Sciences, tom. cxxxiii, p. 349).

[*Not* 1818. Ammonites striatus, Reinecke, Maris protogei Nautilos et Argonautas, pl. viii, figs. 65, 66.—1839. *Goniatites striatus*, G. Münster, Beitr. zur Petrefactenk., i, p. 20.—1843. *Goniatites striatus*, G. Münster, ibid., i, 2nd ed., p. 46.—1843. *Goniatites striatus*, F. A. Roemer, Verstein. Harzgeb., p. 34, pl. ix, fig. 11.—1878. *Goniatites striatus*, H. Abich, Geol. Forsch. in den Kaukasischen Ländern, pt. 1, p. 9, pl. i, figs. 1—3; pl. xi, fig. 2.—1892. *Goniatites striatus*, G. Wild, Trans. Manchester Geol. Soc., vol. xxi, p. 364, pl. ii, fig. 11: "Lower Coal Measures of Lancashire," etc.]

Description.—"Shell subglobose, somewhat compressed, adult with eight sinuous constrictions feebly marked on the outer surface of the test, but very distinct on internal casts; greatest thickness at the margin of the umbilicus, five-eighths of the diameter of the shell; height of outer whorl rather more than three-sevenths of the diameter of the shell. Whorls six to eight; inclusion almost complete; umbilicus rather small, exposing the edges of the inner whorls, about one-sixth of the diameter in width. Whorl semilunate in section, wider than high; indented to nearly two-thirds of its height by the preceding whorl; periphery broadly convex; sides feebly convex, somewhat flattened; inner area nearly perpendicular to the plane of symmetry, slightly concave. Body-chamber occupying a complete whorl; aperture not seen. Chambers not very deep, about twenty in a whorl in an adult shell. [Suture-line as in Pl. XLII, fig. 3, and Pl. XLIII, figs. 2 *a*, *b*.] Test thin, with fine spiral striæ which in the adult shell are crossed by transverse sinuous incised lines forming a wide forwardly directed concave sinus on the periphery: it is thickened at intervals so as to produce well-marked constrictions on internal casts. ('Wrinkle-layer' composed of minute, coarse, wavy, anastomosing rugæ.) Shell attaining a diameter of 85 mm." ('Cat. Foss. Ceph. British Museum,' loc. cit.)

Affinities.—This species, though closely related to *G. sphæricum*, Martin, is distinguished therefrom by its more compressed form and by the spiral lines with which its test is ornamented; the suture-lines of the two species also differ somewhat from each other.

Remarks.—Owing probably to the absence of the test, or to other defects, this species has sometimes been mistaken for *Glyphioceras sphæricum*, Martin, as may be seen by looking at the list of references above. It seems to be rare in Ireland; Phillips has no record for it there, and M'Coy ('Synopsis') has only one, nor does he figure the species. The specimens at my disposal are all more or less crushed fragments, but the sutures and ornamentation are well preserved, and this has made the recognition of the species possible. There being no illustrations of the species in any work treating of Irish fossils, I have figured in Pl. XLIII a fine specimen from Derbyshire contained in the British Museum, in addition to those imperfect ones from the black shale figured in Pl. XLII.

Localities.—Courtlough, Garristown, and Newton, county of Dublin; Drumsera, near Drumquin, county of Tyrone (Sir R. Griffith's 'Localities of the Irish Carboniferous Fossils,' added in 1862 to M'Coy's 'Synopsis').

Sub-genus BEYRICHOCERAS,[1] sub-gen. nov.

GLYPHIOCERAS (BEYRICHOCERAS) OBTUSUM, *J. Phillips*. Plate XLII, figs. 7—9.

1813. ELLIPSOLITES OVATUS, *J. Sowerby*. Min. Conch., vol. i, p. 83, pl. xxxvii (imperfectly defined).
1822. NAUTELLIPSITES OVATUS, *J. Parkinson*. Introd. Foss. Org. Rem., pp. 164 and 233.
1825. GONIATITES OVATUS, *G. de Hann*. Monogr. Ammon. et Goniat., p. 148.
1829. GLOBITES OVATUS, *F. Holl*. Handb. der Petrefactenkunde, p. 226.
1836. GONIATITES OBTUSUS, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 234, pl. xix, figs. 10, 11, ? 13 (not fig. 12 = GLYPHIOCERAS PHILLIPSI, *Foord* and *Crick*, Cat. Foss. Ceph. British Museum, 1897, p. 172).
1838–45. NAUTILUS OVATUS, *L. Agassiz*. In Desor's translation of Sowerby's Mineral Conchology, vol. i, pp. 27 and 65, pl. xxxvii.
1843. GONIATITES OBTUSUS, *J. Morris*. Cat. Brit. Foss., p. 180.
1844. — — *F. M'Coy*. Synops. Carb. Foss. Ireland, p. 15.
1848. — — *J. H. Cumming*. Isle of Man, p. 357.
— — (pars), *H. G. Bronn*. Gesch. der Natur, vol. iii, p. 543.
1849. — — *T. Brown*. Illustr. Foss. Conch. of Great Britain and Ireland, p. 28, pl. xxi, figs. 11, 12.
1850. AGANIDES OBTUSUS, *A. d'Orbigny*. Prod. der Paléont. stratigr., vol. i, p. 115.
1852. AMMONITES SPHÆRICUS (pars), *C. G. Giebel*. Fauna der Vorwelt, vol. iii, p. 471.
1854. GONIATITES OBTUSUS, *J. Morris*. Cat. Brit. Foss., 2nd ed., p. 304.
1855–57. — — *J. Kelly*. Journ. Geol. Soc. Dublin, vol. vii, p. 7.
1878. — — *G. A. Lebour*. Geology of Northumberland, p. 67.
1880. — — *L. G. de Koninck*. Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., tom. v), pt. 2, p. 104, pl. xlvi, fig. 3; pl. xlvii, fig. 10.
1883. — — *L. G. de Koninck*. Bull. Mus. Roy. d'Hist. Nat. Belg., tom. ii, p. 263.
— GLYPHIOCERAS OBTUSUM, *A. Hyatt*. Proceed. Boston Soc. Nat. Hist., vol. xxii, p. 329.
1888. GONIATITES OBTUSUS, *R. Etheridge*. Brit. Foss., vol. i, Palæozoic, p. 312.
1897. GLYPHIOCERAS OBTUSUM, *A. H. Foord and G. C. Crick*. Cat. Foss. Ceph. British Museum, pt. 3, p. 169, fig. 79 (suture-line).
1899. GONIATITES OBTUSUS, *James Spencer*. Proceed. Yorkshire Geol. and Polytech. Soc., new ser., vol. xiii, p. 391.

[1] For definition of this sub-genus see Appendix, p. 219.

Description.—Shell subglobose, involute, slightly compressed on the sides which are feebly convex and subparallel; greatest thickness at the umbilical margin, about four-sevenths of the diameter of the shell; height of outer whorl about one-half of the diameter of the shell. Inclusion of whorls almost complete; umbilicus very small and infundibuliform in the young shell, closed in the adult, with rounded margin. Whorl semi-elliptical in section, height about five-sixths that of the width; indented to about one-half its height by the preceding whorls. Periphery broadly rounded, with a tendency to flattening in the adult shell near the extremity of the body-chamber; inner area very narrow. Body-chamber occupying at least an entire whorl. Chambers not very deep, about fourteen in a whorl; suture-line as in Pl. XLII, figs. 7 *c*, 8 *c*. Test nearly smooth, ornamented with very fine sinuous lines of growth, which are strongly arched forward near the periphery, and form on the latter a deep and broad sinus; they are sometimes accompanied by narrow, obscure folds. One or two broad and shallow constrictions are generally present, especially in adult shells.

Dimensions.

	Uncompressed, but slightly elliptical specimen from Midleton, near Cork.	Elliptical specimen from Little Island, in Mr. Joseph Wright's Collection.
Diameter of shell	55 mm.	73 mm.
„ umbilicus	9 „	5 „
Height of outer whorl	27 „	31 „
„ above preceding whorl	19 „	20 „
Thickness at umbilical margin	32 „	37 „

Owing to distortion in both specimens these measurements are only approximate.

Affinities.—Mr. G. C. Crick and the author of this monograph have shown elsewhere[1] that Phillips had included two distinct species under the name "Goniatites obtusus;" the original of Phillips's pl. xix, fig. 10, was selected as the type of *Glyphioceras obtusum*, and the specimen represented by fig. 12 was separated from the former under the name of *Glyphioceras Phillipsi*. The differences which distinguish the two species are the following:—*G.* (*B.*) *Phillipsi* has a more compressed form and a more prominent umbilical margin than *G.* (*B.*) *obtusum*, and thus it resembles *G.* (*B.*) *diadema*, Beyr., while its suture-line distinguishes it from *G.* (*B.*) *micronotum*, to which it is also related. I have not recognised *G. Phillipsi* among the Irish fossils; the type is in the "Gilbertson Collection" in the British Museum (Register No. C. 5099 *a*), but the locality is unfortunately unknown. *G.* (*B.*) *obtusum* is distinguished from *G.* (*B.*) *subtruncatum* by its much thicker shell, its rounded periphery, and its suture-line, and in the latter character it differs materially from *G.* (*B.*) *occidentale* (p. 170).

[1] Cat. Foss. Ceph. British Museum, pt. 3, p. 169.

Remarks.—The specimens of this species that have come under my notice, though much larger than any previously recorded, are unfortunately for the most part much distorted. They come chiefly from the Cork and Limerick districts. None have been found to my knowledge in the county of Dublin or Kildare. Phillips's figured type came from Bolland in Lancashire, but the first individuals described belonging to this species were collected at Blackrock, in the county of Cork; these were described by J. Sowerby ('Min. Conch.,' i, p. 83) under the name of *Ellipsolites ovatus*, the generic name having been suggested by the ellipticity of the shells, which was assumed by Sowerby to be natural, instead of being artificially produced by rock pressure as was subsequently recognised.

Localities.—Little Island and Midleton, county of Cork; Ballyduff (Dungarvan), county of Waterford; Ballynacarriga, county of Limerick.

Group of Glyphioceras (Beyrichoceras) truncatum.

Glyphioceras (Beyrichoceras) truncatum, *J. Phillips*, sp. Plate XLIII, figs. 5 *a*, *b*; Plate XLIV, figs. 1—4; Plate XLV, figs. 1 *a*—*d*, 2 *a*—*c*; Plate XLIX, fig. 14.

1836.	Goniatites truncatus,	*J. Phillips.*	Geology of Yorkshire, pt. 2, p. 223, pl. xix, figs. 20, 21.
1843.	Nautilus perplanatus,	*J. E. Portlock.*	Geology of Londonderry, p. 403, pl. xxix A, fig. 11.
—	Goniatites truncatus,	*J. Morris.*	Cat. Brit. Foss., p. 180.
1844.	—	*F. M'Coy.*	Synops. Carb. Foss. Ireland, p. 16.
1848.	—	*J. H. Cumming.*	Isle of Man, p. 357.
—	—	*H. G. Bronn.*	Gesch. der Natur, vol. iii, p. 545.
1850.	Aganides truncatus,	*A. d'Orbigny.*	Prod. de Paléont. stratigr., vol. i, p. 115.
1852.	Ammonites truncatus,	*C. G. Giebel.*	Fauna der Vorwelt, vol. iii, p. 474.
1854.	Goniatites truncatus,	*J. Morris.*	Cat. Brit. Foss., 2nd ed., p. 305.
—	Nautilus perplanatus,	*J. Morris.*	Ibid., p. 308.
1855–57.	Goniatites truncatus,	*J. Kelly.*	Journ. Geol. Soc. Dublin, vol. vii, p. 7.
1862.	—	*R. Griffith.*	Ibid., vol. ix, p. 56.
1864.	—	*J. W. Salter.*	Mem. Geol. Surv., Geology of the Country around Oldham, p. 59.
1878.	— truncatus,	*G. A. Lebour.*	Geology of Northumberland, p. 68.
1880.	—	*L. G. de Koninck.*	Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., vol. v), pt. 2, p. 108, pl. xlvi, fig. 5; pl. xlviii, figs. 1—3; pl. xlix, fig. 7; pl. l, fig. 2.
1883.	—	*L. G. de Koninck.*	Bull. Mus. Roy. d'Hist. Nat. Belg., tom. ii, p. 263.

1883. Munsteroceras truncatum, *A. Hyatt.* Proc. Boston Soc. Nat. Hist., vol. xxii, p. 326.
1888. Goniatites truncatus, *R. Etheridge.* Brit. Foss., vol. i, Palæozoic, p. 313.
1889. Glyphioceras truncatum, *E. Holzapfel.* Palæont. Abhandl., Dames und Kayser, vol. v, i, p. 26, pl. i, figs. 8, 9.
1890. Muensteroceras truncatum, *G. Steinmann und L. Döderlein.* Elemente der Palæontologie, pt. 2, p. 393.
1895. Goniatites truncatus, *G. H. Morton.* Proc. Liverpool Nat. Field Club for 1894, p. 24.
1897. Glyphioceras truncatum, *A. H. Foord and G. C. Crick.* Cat. Foss. Ceph. British Museum, pt. 3, p. 175, fig. 82 (suture-line).
1898. — — *G. C. Crick.* Trans. Linn. Soc., ser. 2, vol. vii, p. 108, pl. xx, fig. 19.
1900–1901. Goniatites truncatus, *G. H. Morton.* "The Carboniferous Limestone of Anglesey," Proc. Liverpool Geol. Soc., p. 52.
1903. Glyphioceras truncatum, *Wheelton Hind.* Brit. Assoc. Adv. Sci., Belfast, 1902, p. 215: "Life-zones in the Carboniferous Rocks."

[Not 1854. *Goniatites truncatus*, F. A. Roemer, Palæontographica, vol. iii, p. 94, pl. xiii, fig. 30.—1884. *Glyphioceras truncatum*, A. Hyatt, Proc. Boston Soc. Nat. Hist., vol. xxii, p. 329.]

Description.—Shell attaining a considerable size, much compressed, discoidal, involute; the greatest thickness at about one-third of the height of the whorl from the edge of the umbilicus, rather more than one-third of the diameter of the shell; height of outer whorl three-fifths of the diameter of the shell. Whorls from five to six; inclusion nearly complete; umbilicus small, shallow, from one-seventh to one-ninth of the diameter of the shell in width. Whorl subquadrangular in section, about one-third higher than wide; indented to nearly one-third of its height by the preceding whorl. Periphery more or less flattened or subtruncate, sometimes with perceptible subangular margins; sides very slightly convex, flattened; umbilical zone scarcely distinguishable, gently rounded, merging into the sides of the shell. Body-chamber occupying rather more than a complete whorl; aperture with a deep lateral, and a deep peripheral sinus. Chambers rather deep, eleven or twelve in a whorl; suture-line as in Pl. XLIV, fig. 2 *c*, and Pl. XLIX, fig. 14.

Test thin, with fine sigmoidal lines of growth which become obsolete in large adult specimens. A few constrictions, sometimes strong, sometimes feeble, are present in all stages of growth (Pl. XLIII, fig. 5; Pl. XLIV); these are broad and shallow, and occur apparently at irregular intervals; they are very conspicuous upon the cast, but are scarcely seen upon the test, which seems to fill them up almost entirely. In a very large adult shell, the surface of which is much eroded, there are obscure transverse folds near the aperture representing the lines of growth, and these are seen in other specimens, large and small, under favourable conditions of preserva-

tion, casts sometimes exhibiting them. The shell is for the most part, however, quite smooth.

Dimensions.

	Specimens in the Museum of Science and Art, Dublin. Geol. Surv. Coll. Lisnakerry (No. 4124).	General Coll. Clare.
Diameter of shell . . .	112 mm.	90 mm.
„ umbilicus (edge to edge) .	20 „	17 „
„ „ (suture to suture)	15 „	13 „
Height of outer whorl . .	55 „	46 „
„ above preceding whorl (about) .	29 „	(about) 20 „
Thickness of shell at umbilical margin .	39 „	„ 30 „

These dimensions bring out very clearly the flatness of the shell in this species, its most conspicuous feature, and the one by which it is most easily recognised.

Affinities.—It is quite evident that this species is closely connected with the one described under the name of *Glyphioceras* (*Beyrichoceras*) *subtruncatum* (p. 168). It differs from this in being flatter in form and in the possession of a smaller umbilicus; the truncation of the periphery appears to be equally strongly marked in the two species, and to vary in degree in different individuals. The surface markings are the same in both species, the distinctness of the transverse lines depending very much upon the state of preservation of the shell. Under favourable conditions they constitute in the present species a fairly distinct ornamentation. The constrictions do not in any case constitute a remarkable feature, except in some very young individuals; they are only seen upon the cast, as the test completely covers them. Taking the character of the suture-line into account, it appears that the chambers are somewhat shallower in *G.* (*B.*) *truncatum* than they are in *G.* (*B.*) *subtruncatum*.

Remarks.—The brief description of this species given by Phillips runs as follows:—"Very depressed, back (in adults) truncate; umbilicus open; fine transverse bent striæ." The type specimen being preserved ("Gilbertson Collection," British Museum), the identity of the species was secured, though the feature upon which the author founded it, the truncation of the periphery, is not always so conspicuous as it might be judged to be according to Phillips's figure ('Geol. Yorks.,' pl. xxix, fig. 21). Among the specimens before me the distinctness of the peripheral flattening varies in different individuals, and while in some it is quite apparent in others it is scarcely discernible. This variability, however, does not deprive the species of its individuality, its compressed form, as already stated, supplying the principal specific feature.

Glyphioceras (*Beyrichoceras*) *truncatum* is one of the most common and most widely distributed of the Carboniferous Goniatites in Ireland; it varies considerably in size, and to some extent in thickness, some individuals being much more com-

pressed than others. The flattening of the periphery and the compressed form of the shell are, however, the distinguishing marks of the species, making due allowance for local variability.

Taking the present species as the typical form, the following species added to it make up the group of *G.* (*B.*) *truncatum* :—*G.* (*B.*) *subtruncatum*, *G.* (*B.*) *occidentale*, *G.* (*B.*) *difficile*, *G.* (*B.*) *subquadratum*.

In the supplementary plate (Pl. XLIX, fig. 14) will be seen the suture-line of the present species taken at a point remote from the body-chamber, and therefore probably representing the chambers at their normal distance apart. Fig. 2 *c* of Pl. XLIV, on the other hand, depicts the last three septa, which, as is so commonly the case, are somewhat nearer together. The peripheral lobe in this figure was defective in the specimen, and it is represented much too narrow. Fig. 14 on Pl. XLIX is taken from a specimen about 90 mm. in diameter belonging to the Museum of the Royal College of Science for Ireland, Dublin, kindly lent to the author by Professor Grenville A. J. Cole, M.R.I.A., F.G.S.

Localities.—Drumsera (Drumquin), county of Tyrone; St. Doulagh's, county of Dublin; Clane, county of Kildare; Ballyduff (Dungarvan), county of Waterford; Little Island, Tankardstown (Kildorrery), and Midleton, county of Cork; Lismakerry, Nantenan, Ballycahane, and Kilmacat, county of Limerick.

Glyphioceras (Beyrichoceras) subtruncatum, sp. nov. Plate XLV, figs. 3 *a*—*d*, 4 *a*—*c*.

Description.—Shell of medium size, discoid, somewhat compressed, composed of from six to seven whorls (?); the greatest thickness at about one-fourth of the height of the whorl from the edge of the umbilicus, about three-sevenths of the diameter of the shell; height of outer whorl about four-sevenths of the diameter of the shell. Inclusion of the whorls nearly complete; umbilicus small in the young and adolescent stage of growth, but proportionately larger in the adult. Whorl subquadrangular in section, about one-third higher than wide, indented to about one-third of its height by the preceding whorl. Periphery about one-third of the height of the outer whorl in width, more or less perceptibly flattened; umbilical zone indistinct, gently convex, merging in the sides of the shell. Body-chamber occupying rather more than an entire volution; aperture, so far as may be judged by the lines of growth, with a prominent crest in young individuals (Pl. XLV, fig. 4 *a*), which becomes somewhat less strongly marked in older ones. Chambers moderately deep, apparently sixteen or seventeen to a whorl. Suture-line as in Pl. XLV, fig. 3 *d*.

Test thin for the most part, but becoming thicker in the umbilical region, having

faint lines of growth which on leaving the umbilicus curve forwards, then a little backwards, and again more prominently forwards so as to form a crest just below the periphery. One or two shallow constrictions are seen upon the cast, but the test when present quite conceals them.

Dimensions.

	Specimen in the Museum of Science and Art, Dublin (Geological Survey Coll.). Nantenan.
Diameter of shell . . .	70 mm.
,, umbilicus (edge to edge) .	7 ,,
Height of outer whorl . . .	39 ,,
,, above preceding whorl (about) .	19 ,,
Thickness of shell at umbilical margin .	30 ,,

By comparing these measurements, taken from an undistorted specimen, with those of *Glyphioceras* (*Beyrichoceras*) *truncatum* (p. 167), the greater thickness of the shell in the present species becomes apparent.

Affinities.—On comparing the figures of this species with those of *Glyphioceras* (*Beyrichoceras*) *truncatum*, the chief resemblance between the two will be clearly seen. Both of them have the peripheral flattening more or less strongly emphasised in the adult shell, and there is a similarity in the umbilical characters, smoothness of the test, etc.; but in the present species the shell is much thicker and more inflated, and it is upon this character that the main distinction between the two species is based. The peripheral lobe of the suture-line is also both broader and deeper in *G.* (*B.*) *subtruncatum* than it is in *G.* (*B.*) *truncatum*, its greater breadth naturally corresponding with the superior breadth of its peripheral area. *G.* (*B.*) *inconstans*, de Kon.,[1] is another species which will very well bear comparison with *G.* (*B.*) *subtruncatum*, and de Koninck points out its resemblance also to *G.* (*B.*) *truncatum*. It differs from both in the greater size of its umbilicus in the adult stage of growth and in the regular constrictions which occur in the young shell (De Koninck, loc. cit., pl. xlviii, fig. 1). The larger size and angular margin of the umbilicus in *G. inconstans* are the most striking differences between this species and *G. subtruncatum*.

The present species differs from *G. obtusum* in its more slender habit, in the truncation or less broadly rounded character of the periphery, and in the structure of the suture-line.

Remarks.—This species has so far been found chiefly in the south and south-west of Ireland, in the counties of Tipperary and Limerick.

[1] Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Palæont., tom. v), pt. 2, p. 120, pl. xlviii, figs. 4—9.

Localities.—Clonmel, county of Tipperary (from Mr. Joseph Wright's collection); Ballynacarriga (Nos. 301, 778, and 1519 of the Geol. Surv. Coll.), Nantenan (Nos. 259 and 4712), and Fannigtown (No. 1141), county of Limerick.

GLYPHIOCERAS (BEYRICHOCERAS) OCCIDENTALE, sp. nov. Plate XLV, figs. 5 *a*, *b*, 6 *a*, *b*.

Description.—Shell of medium size, discoid, somewhat compressed, close-coiled, the greatest thickness at about one-third of the height of the whorl from the umbilicus, about one-half of the diameter of the shell; height of the outer whorl about five-sixths of the diameter of the shell. Inclusion of the whorls nearly complete; umbilicus small. Whorl semi-elliptical in cross-section, about one-fourth higher than wide, indented to nearly half its height by the preceding whorl. Periphery rounded. Umbilical zone indistinct, merging with a very slight convexity in the sides of the shell. Body-chamber occupying at least one entire whorl; aperture, as indicated by the lines of growth, with a shallow hyponomic sinus upon the periphery and a somewhat prominent crest upon the upper third of the lateral margin. One or two shallow constrictions occur, marked only upon the cast. Chambers somewhat deep as seen in the rather widely spaced suture-lines (Pl. XLV, fig. 5 *c*), the peripheral lobe large as compared with the lateral lobe. Test almost smooth, the lines of growth pursuing the direction taken by the outline of the aperture just described.

Dimensions.

	Specimens from Kerry in the Museum of Science and Art, Dublin (Geological Survey Collection). (No. 4169.)	(No. 3786.)
Diameter of shell	55 mm.	43·0 mm.
„ umbilicus	9 „	5·0 „
Height of outer whorl	30 „	21·5 „
„ above preceding whorl	15 „	9·0 „
Thickness at umbilical margin	28 „	19·0 „

Affinities.—This species resembles *G.* (*B.*) *rotella*, de Kon.,[1] in many particulars, and I should have hesitated to separate them but for the much larger umbilicus of the latter. The sutures are remarkably similar to each other in form in the two species, though de Koninck gives no information as to their distance

[1] Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., tom. v), pt. 2, p. 106, pl. xlix, figs. 14, 14*a*.

apart in *G. rotella*. The rotundity of the periphery and the smoothness of the test are the same in both species. *G.* (*B.*) *complanatum*, de Koninck,[1] bears also some resemblance to the present species, but it is a more slender shell and the septa are much closer together. The smooth test, rounded periphery, more inflated sides, and distant septa distinguish the present species from *G.* (*B.*) *subtruncatum*, though in spite of these differences, which are rather of degree than of kind, the resemblance between the two species cannot fail to be observed.

Remarks.—The specific name given to this species refers to the localities whence it was obtained, being in the western part of Ireland.

Localities.—Ballinacarriga, county of Limerick (301 C., 1519 C.); Garrihies, county of Kerry (661 C., 3786 C., 4169 C.).

GLYPHIOCERAS (BEYRICHOCERAS) DIFFICILE, sp. nov. Plate XLVI, figs. 1 *a*—*c*.

Description.—Shell (cast) discoid, thick, somewhat compressed, the greatest thickness at the umbilical margin. Owing, however, to a peculiar distortion of the shell whereby the upper half is shifted sideways in relation to the lower half along a line bisecting the shell diagonally, this measurement cannot be given accurately, but it represents rather less than one-half of the diameter of the shell; height of the outer whorl somewhat less than three-fifths of that diameter. Inclusion of the whorls nearly complete; umbilicus small. Whorl subsagittate in cross-section, somewhat higher than wide. Periphery rather narrowly rounded. As the fragment described is entirely septate, nothing is known of the body-chamber. Chambers rather shallow. Suture-line as in Pl. XLVI, fig. 1 *c*. Test unknown, the fragment that remains being too much eroded to show any trace of ornamentation.

Dimensions.

	Specimen in the Museum of Science and Art, Dublin (Geological Survey Collection).
Diameter of shell (cast) (about) . . .	76 mm.
„ umbilicus (about) . . .	10 „
Height of outer whorl (about) . . .	42 „
Thickness at umbilical margin (about) . .	33 „

Affinities.—Both in its general form and in the conformation of its suture-line the present species bears a very striking resemblance to *Glyphioceras Hispanicum*, Foord and Crick,[2] and perhaps with better material the identity of the two species

[1] Loc. cit., pl. xlvi, figs. 4, 4 *a*.

[2] 'Cat. Foss. Ceph. Brit. Mus.,' pt. 3, p. 190, figs. 91 *a*—*c*.

might have been established. On the other hand, the numerous constrictions sometimes present in *G. Hispanicum* appear to be entirely wanting in *G. difficile*, which has also a thicker shell. On the whole it seemed better to give a distinctive name to the Irish species rather than to merge it in the Spanish one upon the imperfect information available.

Glyphioceras (*Beyrichoceras*) *difficile* may, however, very appropriately take its place in the group of *G.* (*B.*) *truncatum* and its allies. The difficulty I have experienced in separating the forms included in this group is in itself a measure of their very close affinities.

Locality.—Lisnakerry, county of Limerick.

GLYPHIOCERAS (BEYRICHOCERAS) SUBQUADRATUM, sp. nov. Plate XLVI, figs. 2 *a*—*c*.

Description.—Shell discoidal, compressed, sides moderately convex, the periphery distinctly flattened, with well-defined lateral angles; umbilicus rather large, deep; umbilical zone narrow, nearly perpendicular, the edges subangular. Inner whorls exposed only at their edges; inclusion nearly complete. Whorl subquadrate in section owing to the marked truncation of the periphery; greatest thickness at the umbilical margin, a little more than five-sevenths of the height. Suture-line as in Pl. XLVI, fig. 2 *c*. Test, seen in a young individual, ornamented with extremely fine imbricating (?) striæ, which form a gentle sigmoidal curve in crossing the sides of the shell, and a deeply indented sinus in crossing the periphery. Several shallow constrictions are present on the cast.

Dimensions.

	Specimen from Little Island, Cork, in the Bristol Museum.
Diameter of shell (longer) . . .	78 mm.
„ „ (shorter) (about) . .	50 „
„ of umbilicus (longer) . . .	20 „
„ „ (shorter) . . .	17 „
Height of outer whorl . . .	35 „
Thickness at umbilical margin . .	28 „

From these dimensions it will be seen that the specimen measured has been distorted into an elliptical shape, and this is precisely the case with another specimen from the same locality from which the suture-line (Pl. XLVI, fig. 2 *c*) has been drawn.

Affinities.—Notwithstanding the much greater size of the umbilicus in this species compared with that which is met with in species belonging to the group

of *Glyphioceras truncatum*, the resemblance to this series in other features is noteworthy, especially in the flattened sides and truncated periphery. The suture-line also is not very dissimilar, comparing together, *e. g.*, the suture-line of *G. difficile* with that of *G. subquadratum* (Pl. XLVI, figs. 1 *c* and 2 *c*).

Remarks.—The specimen from which the above description was chiefly drawn up having come unexpectedly into my hands after the plates had all been printed, I have not been able to figure it; the one referred to at the head of this description must therefore suffice to represent it, and it in fact gives all essential features, the details of the umbilicus being alone deficient; these are supplied by the recently available specimen. The latter thus fulfils the double office of amplifying structural details, and of confirming the existence of a specific form whose validity might, upon the evidence of a single specimen, have been called in question.

Locality.—Little Island, near Cork.

GLYPHIOCERAS (BEYRICHOCERAS) SPHÆROIDALE? *M'Coy.* Plate XLVI, figs. 3 *a*, *b*; 5 *a*, *b*.

1844. GONIATITES SPHÆROIDALIS, *F. M'Coy.* Synops. Carb. Foss. Ireland, p. 15, pl. iv, fig. 18.
1850. AGANIDES SPHÆRICUS (pars), *A. d'Orbigny.* Prod. de Paléont. stratigr., vol. i, p. 115.
1852. AMMONITES SPHÆRICUS (pars), *C. G. Giebel.* Fauna der Vorwelt, Bd. iii, Abth. i, p. 471.
1854. GONIATITES SPHÆROIDALIS, *J. Morris.* Cat. Brit. Foss., 2nd ed., p. 304.
1862. — — *R. Griffith.* Journ. Geol. Soc. Dublin, vol. ix, p. 55.
1880. — — *L. G. de Koninck.* Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., tom. v), pt. 2, p. 99, pl. xlvii, figs. 6, 7; pl. xlviii, figs. 10—12.
1889. GLYPHIOCERAS SPHÆROIDALE, *E. Holzapfel.* Palæont. Abhandl., Dames und Kayser, Bd. v, i, p. 30.
1897. — *A. H. Foord and G. C. Crick.* Cat. Foss. Ceph. British Museum, pt. 3, p. 183.

Description.—Shell spheroidal, somewhat compressed laterally, rather widely umbilicated; greatest thickness at the margin of the umbilicus, about four-sevenths of the diameter of the shell, height of outer whorl about three-sevenths of that diameter. Number of whorls unknown. Inclusion fully three-fourths. Umbilicus probably of moderate depth, but not fully available for examination. Whorl semilunate in section, nearly twice as wide as high, indented to about three-fourths of

its height by the preceding whorl; sides somewhat flattened, peripheral area very distinctly flattened in the young shell with a fairly well-marked rounded margin.

Body-chamber not seen. The suture-line is described but imperfectly figured by M'Coy (loc. cit.); it is, however, figured by de Koninck (loc. cit., p. 99). Test ornamented with fine transverse lines of sigmoidal form crossed by faint longitudinal ridges both upon the sides and the peripheral area. A series of very narrow and shallow constrictions are developed, about ten to a whorl; these proceed from the region of the umbilicus with a slight, backwardly directed curve and cross the peripheral area, making upon it a broad, backwardly directed sinus and a well-marked angle at its margin on each side (Pl. XLVI, fig. 5 *a*).

Dimensions.

	Young shell from Ballinacarriga in the Dublin Museum of Science and Art (Geological Survey Collection). (No. 255.)
Diameter of shell . . .	35·0 mm.
„ umbilicus . .	10·0 „
Height of outer whorl . .	15·5 „
„ above preceding whorl . .	8·0 „
Thickness at umbilical margin . .	22·5 „

Affinities.—This species is distinguished from *G. Browni*, M'Coy (p. 175), by its smaller umbilicus, more inflated form, and by its ornamentation. It agrees well in respect to the latter feature with de Koninck's specimens as figured by him (loc. cit.), though the umbilicus in the Irish specimens is a little smaller. M'Coy gives only one figure of this species, a lateral view, and therefore the peripheral flattening so well marked in the specimen from Ballinacarriga (Pl. XLVI, fig. 5) is not exhibited. The present species differs both in sutural characters and in ornamentation, as well as in the flattening of the periphery, from *G.* (*B.*) *sphæricum*.

Remarks.—A specimen (Pl. XLVI, fig. 3) from Kilmallock (county of Limerick), contained in the "Griffith Collection," has the name of this species written upon the tablet on which it is mounted, and it has been doubtfully referred to M'Coy's type (loc. cit.), but if it be this M'Coy's figure is inaccurate, as the umbilicus is represented as being much larger than it is in the specimen. The figure also shows a part of the suture-line upon the last whorl, whereas no trace of this is seen upon the specimen. On the whole, however, it appears to belong to the species to which it has been assigned, viz. *G.* (*B.*) *sphæroidale*.

Localities.—Ballyrichard, county of Cork (No. 4767—Dublin Museum of Science and Art, Geological Survey Collection); Kilmallock and Ballinacarriga, county of Limerick.

GLYPHIOCERAS (BEYRICHOCERAS) BROWNI? *F. M'Coy*, sp. Plate XLVI, figs. 4 *a*—*c*.

1844.	GONIATITES BROWNI, *F. M'Coy*.		Synops. Carb. Foss. Ireland, p. 12, pl. iv, fig. 17.
1880.	—	— *L. G. de Koninck*.	Faune Calc. Carb. Belgique (Ann. Mus. Roy. d'Hist. Nat. Belgique, sér. Paléont., tom. v), pt. 2, p. 98.
1889.	GLYPHIOCERAS BROWNI, *E. Holzapfel*.		Palæont. Abhandl., Dames und Kayser, Bd. v, i, p. 30.
1897.	—	— *A. H. Foord and G. C. Crick*.	Cat. Foss. Ceph. British Museum, pt. 3, p. 183.
1899.	—	— *G. C. Crick*.	Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 438.

Description.—The following is M'Coy's description:—"Discoid, subglobose, sides flattened; umbilicus large, acute-edged, exceeding one-third the diameter of the shell; surface smooth; septa, dorsal lobe small, bifid; dorsal sinus acute; first lateral lobe slightly exceeding the dorsal in length, very wide, rounded; lateral sinus twice as long as the dorsal, acute, linguiform; second lateral lobe very wide, obtusely rounded.

"From the *G. striatus*, Sow., which the species most resembles, it is distinguished internally by its much shorter and wider first lateral lobe; the same character distinguishes it from the *G. sphæricus*, Sow., and from both it is distinguished externally by its smooth surface, and from all the species of the same form by the large size of the umbilicus. Diameter two inches two lines; thickness one inch one line."

Remarks.—The type of this species has been lost, and there is therefore only M'Coy's figure and description to serve for its identification. A distorted specimen bearing the name "*Goniatites sphæroidalis*" is contained in the "Griffith Collection," and this I refer with considerable doubt to M'Coy's species. To give its dimensions would be misleading, as its original form has been converted by pressure into a long ellipse. The principal ground for the determination of its affinities rests upon the size of the umbilicus, which, as in M'Coy's representation of the species, is remarkably large, being approximately one-half of the shorter diameter of the shell and about one-third of the longer. The suture-line is too imperfect for comparison with the one figured by M'Coy (loc. cit.), otherwise it would have afforded very important information. The test, which is not well preserved, bears upon its surface a few faint longitudinal ridges and

concentric lines of growth, which form a deep and wide hyponomic sinus upon the periphery.

The name of this species does not occur in Sir R. Griffith's list of localities appended to M'Coy's 'Synopsis' (1862), but the tablet is inscribed "Co. Limerick —Presented by Sir R. Griffith, Bart."

Locality.—County of Limerick (exact locality unknown).

GLYPHIOCERAS (BEYRICHOCERAS) CORPULENTUM, *G. C. Crick*. Plate XLVII, figs. 1 *a*, *b*; Plate XLVIII, figs. 1 *a*—*c*.

1899. GLYPHIOCERAS CORPULENTUM, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 447, fig. 12.

Description.—Shell much inflated, the greatest thickness at the umbilical margin, about three-fifths of the diameter of the shell; the height of the outer whorl nearly one-half of the same. Whorls few, their number not determinable from the specimens available; inclusion nearly complete owing to the greatly expanded sides of the shell; umbilicus deep, with subangular margin and precipitous sides; about three-tenths of the diameter of the shell in width. Whorl sublunate in cross-section; the height about three-fourths of the width; indented to nearly one-half of its height by the preceding whorl. Periphery broadly convex, imperfectly defined; merging in the inflated sides. Umbilical zone distinctly defined, narrow, nearly perpendicular to the plane of symmetry of the shell.

Body-chamber occupying nearly the whole of the last whorl; aperture not preserved, but the lines of growth indicate the presence of a slight crest near the edge of the umbilicus, and a very wide and shallow hyponomic sinus. Chambers shallow; suture-line as in Pl. XLVIII, fig. 1 *c*.

Test ornamented with fine, subregular, raised lines, which become more distinct in the adult shell; these extend obliquely and abruptly backwards from the umbilical margin and form a very wide and shallow sinus upon the periphery. The latter bears some widely spaced, faintly defined longitudinal bands in the adult; in the young shell these bands extend to the sides of the shell; though not a very conspicuous feature, these longitudinal bands give a certain distinguishing character to the ornamentation of the shell when viewed in connection with the transverse lines, and as they persist throughout the growth of the shell they are of definite value as specific data.[1] The cast in the adult individual shows near the aperture two wide and shallow but quite conspicuous constrictions, and there are indications of similar features in the young shell.

[1] The lithographer has omitted the longitudinal bands in the figures of the young shell (Pl. XLVIII, figs. 1 *a*, *b*).

Dimensions.

	Specimens in the Museum of Science and Art, Dublin. Adult specimen (type).	Young specimen.
Diameter of shell . . .	95 mm.	65·0 mm.
„ umbilicus (edge to edge) .	25 „	20·0 „
„ „ (suture to suture)	22 „	15·5 „
Height of outer whorl . .	45 „	27·0 „
„ above preceding whorl .	25 „	18·0 „
Thickness at umbilical margin (about) .	58 „	40·5 „

Affinities.—In his description of this species Mr. Crick has not ventured to suggest any comparison of it with others, and it is in fact difficult to institute any satisfactory one, so distinct does its principal feature prove to be, that is, the extremely globose form of its whorls. In considering its affinities in a more comprehensive sense the character of the suture-line indicates these to be with *Beyrichoceras* rather than *Münsteroceras*. The suture-line of *G.* (*B.*) *truncatum* (Pl. XLIV, fig. 2 *c*, and Pl. XLIX, fig. 14), *e. g.*, is not unlike that of the present species, and there is another feature in which these species resemble each other, and that is in the possession of broad and very shallow constrictions[1] at irregular intervals on the surface of the cast.

Remarks.—Only three specimens of this species are known to me, the two figured on Pls. XLVII and XLVIII, from which Mr. Crick drew up his description of the species, and another smaller one which passed through my hands; all are from the same place.

Locality.—St. Doulagh's, county of Dublin.

GLYPHIOCERAS (BEYRICHOCERAS) MICRONOTUM, *J. Phillips*, sp. Plate XLIV, figs. 5 *a*, *b*.

1836.	GONIATITES MICRONOTUS, *J. Phillips.*		Geology of Yorkshire, pt. 2, p. 234, pl. xix, figs. 22, 23.
1843.	—	—	*J. Morris.* Cat. Brit. Foss., p. 180.
1844.	—	—	*F. M'Coy.* Synops. Carb. Foss. Ireland, p. 14.
1848.	—	—	*J. H. Cumming.* Isle of Man, p. 357.
—	—	—	*H. G. Bronn.* Gesch. der Natur, vol. iii, p. 543.
1850.	AGANIDES MICRONOTUS, *A. d'Orbigny.*		Prod. de Paléont. stratigr., vol. i, p. 115.
1852.	AMMONITES MICRONOTUS, *C. G. Giebel.*		Fauna der Vorwelt, vol. iii, p. 474.

[1] Two of these are seen close together on the specimen figured on Pl. XLVII, fig. 1 *a*, at the upper part of the latter.

1854.	Goniatites micronotus,	*J. Morris.*	Cat. Brit. Foss., 2nd ed., p. 304.
1855–57.	—	*J. Kelly.*	Journ. Geol. Soc. Dublin, vol. vii, p. 7.
1880.	—	*W. Branco.*	Palæontographica, vol. xxvii, p. 24, pl. iv, fig. iv *a*—*l*.
1883.	Glyphioceras micronotum,	*A. Hyatt.*	Proc. Boston Soc. Nat. Hist., vol. xxii, p. 329.
1888.	Goniatites micronotus,	*R. Etheridge.*	Brit. Foss., vol. i, Palæozoic, p. 312.
1889.	Glyphioceras micronotum,	*E. Holzapfel.*	Palæont. Abhandl., Dames und Kayser, vol. v, i, p. 28, pl. ii, fig. 1.
1897.	—	*A. H. Foord and G. C. Crick.*	Cat. Foss. Ceph. British Museum, pt. 3, p. 173, fig. 81 (suture-line), also fig. 74 (developmental).

Description.—"Shell discoidal, compressed, involute; greatest thickness at the umbilical margin, about one-half of the diameter of the shell; height of outer whorl a little more than one-half of the diameter of the shell. Whorls (? number); inclusion almost complete; umbilicus narrow, about one-twelfth of the diameter of the shell, infundibuliform, with subangular margin. Whorl semi-elliptical in section, a little higher than wide; indented to three-sevenths of its height by the preceding whorl; periphery narrowly convex; sides feebly convex, flattened; inner area narrow, sloping towards the umbilicus, somewhat flattened. Body-chamber occupying at least two-thirds of the last whorl. Chambers shallow, about nine in the last half-whorl preceding the body-chamber. Test thin, ornamented with very fine striæ, which are slightly waved on the sides and form a deep, broad, backwardly directed sinus on the periphery. Internal casts sometimes with four shallow constrictions having the same course as the ornaments, being deepest at the periphery and becoming very feeble near the umbilicus. Initial chamber ellipsoidal or spindle-shaped, transversely elongate. Shell attaining a diameter of about 33 mm." ('Cat. Foss. Ceph. British Museum,' loc. cit.)

Affinities.—Holzapfel (loc. cit.) compares the suture-line of the present species with that of *Glyphioceras* (*Beyrichoceras*) *truncatum*, Phil., but the resemblance is not very close. The whorls in the former are more compressed than in the latter species. The ornaments of the test in *G. micronotum* would be the best guide for distinguishing the species.

Remarks.—The single individual in the "Griffith Collection" bearing the name of *G.* (*B.*) *micronotum* is very small and badly preserved, and is partly covered by the rock in which it is embedded. I have therefore figured a larger and better specimen in the British Museum; this one is labelled "Kildare, Ireland."

Localities.—Clane, county of Kildare (exact locality in the county unknown); Ballinacourty (Dungarvan), county of Waterford (*fide* Griffith).

GLYPHIOCERAS (BEYRICHOCERAS) DIADEMA? *H. E. Beyrich*, sp. Plate XLVII, figs. 4, 5, 6 *a*, *b*; Plate XLIX, figs. 8 *a*, *b*.

	1832.	AMMONITES DIADEMA (*Goldfuss*), *A. H. Dumont.*	Mém. const. géol. Liège, p. 356 [nom. nud.].
?	1835.	GONIATITES STRIOLATUS, *J. Phillips.*	Geology of Yorkshire, pt. 2, p. 234, pl. xix, figs. 14—18.
	1837.	AMMONITES DIADEMA (*Goldfuss*), *H. E. Beyrich.*	De Goniatitis in montibus rhenanis occurrentibus, p. 15, pl. ii, figs. 8—10.
		— LISTERI, *H. E. Beyrich.*	Ibid., p. 14, pl. ii, figs. 6 *a*, *b*, 11.
		— DIADEMA (*Goldfuss*), *E. Beyrich.*	Beitr. zur Kenntn. Verstein. rhein. Uebergangsgeb., p. 41, pl. ii, figs. 8—10 (descriptions and figures as in 'De Goniatitis').
		— LISTERI, *E. Beyrich.*	Ibid., p. 39, pl. ii, figs. 6 *a*, *b*, 11.
	1842–44.	— DIADEMA, *L. G. de Koninck.*	Descr. Anim. Foss., p. 574, pl. l, figs. 1 *a*—*f*, 2 *a*, *b*.
	1843.	GONIATITES DIADEMA, *L. G. de Koninck*, in J. J. d'Omalius d'Halloy, Précis élém. géol. p. 515.	
	—	— BEYRICHIANUS, *L. G. de Koninck.*	Ibid., p. 515.
?	—	— STRIOLATUS, *J. Morris.*	Cat. Brit. Foss., p. 180.
?	1844.	— *F. M'Coy.*	Synops. Carb. Foss. Ireland, p. 16.
	1845.	— DIADEMA, *E. de Verneuil*, in Murchison, de Verneuil, and de Keyserling, Géol. Russie d'Europe, vol. ii, p. 367, pl. xxvii, figs. 1 *a*—*d*.
?	1848.	— STRIOLATUS, *J. H. Cumming.*	Isle of Man, p. 357.
		— DIADEMA, *H. G. Bronn.*	Gesch. der Natur, vol. iii, p. 541.
	1850.	AGANIDES DIADEMA, *A. d'Orbigny.*	Prod. de Paléont. Stratigr., vol. i, p. 116.
?	—	— STRIOLATUS, *A. d'Orbigny.*	Ibid., p. 115.
	1851.	GONIATITES DIADEMA, *G. Sandberger.*	Jahrb. Nassau Verstein. Nat., pt. vii (ii and iii), p. 304, pl. iii, fig. 33.
	1852.	AMMONITES LISTERI (pars), *C. G. Giebel.*	Fauna der Vorwelt, vol. iii, p. 475.
	1854.	GONIATITES DIADEMA, *J. Morris.*	Cat. Brit. Foss., 2nd ed., p. 303.
?	-	— STRIOLATUS, *J. Morris.*	Ibid., p. 304.
	1855.	AGANIDES DIADEMA, *F. M'Coy.*	Brit. Pal. Foss., p. 563.
?	1855–57.	GONIATITES STRIOLATUS, *J. Kelly.*	Journ. Geol. Soc. Dublin, vol. vii, p. 7.
?	1863.	— DIADEMA, *F. Roemer.*	Zeitschr. Deutsch. Geol. Gesell., vol. xxv, p. 578, pl. xv, figs. 1 *a*—*c*.
		— LISTERI, *F. Roemer.*	Ibid., vol. xv, p. 580, pl. xv, figs. 2 *a*, *b*.
	1880.	— DIADEMA, *W. Branco.*	Palæontographica, vol. xxvii, pl. iv, fig. 1.
	1883.	GLYPHIOCERAS DIADEMA, *A. Hyatt.*	Proc. Boston Soc. Nat. Hist., vol. xxii, p. 329.

1884. "Ammonites diadema, L. v. Buch," *E. Beyrich.* Zeitschr. Deutsch. Geol Gesell., vol. xxxvi, pp. 213—215.

1888. Goniatites diadema, *R. Etheridge.* Brit. Foss., vol. i, Palæozoic, p. 311.

? — — striolatus, *R. Etheridge.* Ibid., p. 313.

1889. Gastrioceras diadema, *E. Holzapfel.* Paläont. Abhandl., Dames und Kayser, vol. v, i, p. 26.

1890. Glyphioceras diadema, *G. Steinmann und L. Döderlein.* Elemente der Paläontologie, pt. 2, p. 393.

1894. — — *A. Hyatt.* Proceed. Amer. Philos. Soc., vol. xxxii, p. 620, pl. ii, fig. 27, "Phylogeny of an Acquired Characteristic."

1895. — — *K. A. v. Zittel.* Grundzüge der Paläontologie, p. 399.

1897. — — *A. H. Foord and G. C. Crick.* Cat. Foss. Ceph. British Museum, pt. 3, p. 202, figs. 98 *a—c.*

— — — *James Perrin Smith.* "Development of Glyphioceras and the Phylogeny of the Glyphioceratidæ," Proceed. California Acad. Sci., ser. 3, Geology, vol. i, pp. 110, 111.

1899. Goniatites striolatus, *James Spencer.* Proceed. Yorkshire Geol. and Polytech. Soc., new ser., vol. xiii, pt. 4, p. 391.

1901. Glyphioceras diadema, *Wheelton Hind and J. A. Howe.* Quart. Journ. Geol. Soc., vol. lvii, p. 372, etc.

1903. — — *Wheelton Hind.* Brit. Assoc. Adv. Sci., Belfast, 1902, p. 215, "Life-zones in the Carboniferous Rocks."

Description.—"Shell variable, discoidal, umbilicated, the young much more inflated than the adult; greatest thickness near the edge of the umbilicus, about two-fifths of the diameter of the shell; height of outer whorl about one-half of the diameter of the shell. Whorls (? number); inclusion nearly complete; umbilicus shallow, about one-fifth of the diameter of the shell in width, the edge with a slightly raised rim in the young shell, but wanting this in the adult. Whorl almost semilunate in section in the young, elongate-oval in the adult, higher than wide (in the young the reverse of this is the case); indented to nearly one-half of its height by the preceding whorl; periphery narrowly convex; sides inflated in the young, compressed in the adult; inner area flat, sloping towards the umbilicus, and thus forming an obtuse angle with the sides of the shell. Body-chamber occupying at least one whorl. Chambers very shallow, eighteen or nineteen to a whorl. Test ornamented with fine striæ, most of which bifurcate in the umbilical region in the adult shell; they are sigmoidal upon the sides of the shell, and form a backwardly directed, linguiform sinus on the periphery; in very young shells the striæ are

simple and their course is nearly straight. A number of shallow constrictions (from three to five per whorl) concurrent with the striæ are present, and are more conspicuous on casts. Initial chamber ellipsoidal or spindle-shaped, transversely elongate."

"This species is very variable: sometimes it has a relatively small umbilicus and a rather finely ornamented test, the young having much the same characters but being rather more inflated; sometimes it has an open umbilicus and a more or less coarsely striated test, the ornaments being much coarser in the young than in the adult. Since there are intermediate forms connecting the two extremes, and as they all have the same form of suture-line, we refer them to one species.

"Shell attaining a diameter of 66 mm." ('Cat. Foss. Ceph.,' loc. cit.)

Affinities.—This species is not unlike the young forms of *Glyphioceras* (*Beyrichoceras*) *truncatum*, but the periphery is rounded, and, when the suture-lines are compared, it is seen that the resemblance is only superficial and external. A feature which calls for notice in the suture-line of the present species is the considerable height and width of the peripheral lobe, for which it is difficult to find a parallel in any other species of *Glyphioceras*, the only one coming near to it being *G. Phillipsi*, Foord and Crick.[1] This species differs, however, from the present one in its more compressed form and narrower umbilicus. As compared with *G.* (*B.*) *excavatum*, J. Phillips, *G.* (*B.*) *diadema* has a smaller umbilicus and very distinct sigmoidal lines of growth, while the suture-line has a much more elevated median saddle.

Remarks.—I have referred some specimens rather doubtfully to this species. These are represented by figs. 4, 5, and 6 on Pl. XLVII, and fig. 8 on Pl. XLIX. The former consist of pyritised casts contained in a slaty rock, from which it is difficult to extract them whole. The suture-lines are beautifully preserved, and appear as delicate lines traced upon the smooth surface of the cast. The specimens are all small, the largest measuring only 27 mm. in diameter, the smallest about 12 mm. Shallow constrictions are present in all the specimens.

A specimen in the museum of the Royal College of Science for Ireland, from a locality "four miles east of Loughrea," seems also to have some claim to belong to the present species. The lines of growth have the distinctly sigmoid curvature in crossing the sides of the shell, characteristic of *G.* (*B.*) *diadema*. The periphery is somewhat depressed, and the umbilicus is small. The sutures are not seen. The specimen measures 48 mm. in diameter.

The specimen figured on Pl. XLIX (fig. 8) has now to be referred to. The most prominent feature in this is the distinctly sigmoidal character of the lines crossing the sides of the shell, and becoming more prominent where they bend sharply forward near the periphery. This is quite characteristic of the species to which

[1] 'Cat. Foss. Ceph. British Museum,' pt. 3, p. 172, fig. 80 (suture-line).

I have doubtfully referred this form. The rather large and open umbilicus is not quite in accordance with the more typical forms of *G. diadema*, though it has been pointed out that that species has sometimes a small, sometimes a comparatively large umbilicus.[1]

It must be observed that if the interpretation of this fossil is the correct one, the horizon of the species would be extended below that in which it has hitherto been identified, viz. the Yoredale Series.

Some specimens (casts) from Redesdale, Yorkshire, kindly lent to me by Dr. Wheelton Hind (agreeing remarkably well with de Verneuil's excellent figures[2]), have been very useful to me for comparison with the Irish specimens. The evidence in favour of the affinities of the latter here suggested seems fairly well grounded, though the absence of the test in the pyritised casts, and of the suture-line in the other two specimens, introduce an element of doubt.

There is little likelihood that all the forms assigned to *Glyphioceras diadema* really belong to the species described by Beyrich under that name, but as it has attained the distinction of being a very variable species it is hard to determine what are its limitations.

Localities.—Kinsale, county of Cork. "Four miles east of Loughrea," county of Galway.

Group of Glyphioceras (Beyrichoceras) reticulatum.

Glyphioceras (Beyrichoceras) reticulatum, *J. Phillips*, sp. Plate XLIX, figs. 2 *a*, *b*, 3 *a*, *b*.

1836. Goniatites reticulatus, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 235, pl. xix, figs. 26—32.
— — Gibsoni, *J. Phillips*. Ibid., p. 236, pl. xx, figs. 13—18.
1841. — jugosus, *T. Brown*. Trans. Manchester Geol. Soc., vol. i, p. 215, pl. vii, figs. 14, 15.
1843. — Gibsoni, jugosus, reticulatus, *J. Morris*. Cat. Brit. Foss., pp. 179, 180.
1844. — Gibsoni, reticulatus, *F. M'Coy*. Synops. Carb. Foss. Ireland, pp. 13, 15.
1848. — reticulatus, *J. H. Cumming*. Isle of Man, p. 357.
— — Gibsoni, jugosus, reticulatus, *H. G. Bronn*. Gesch. der Natur, vol. iii, pp. 542, 544.
1850. Aganides diadema (pars), *A. d'Orbigny*. Prod. de Paléont. stratigr., vol. i, p. 116.

[1] 'Cat. Foss. Ceph. Brit. Mus.,' pt. 3, 1897, p. 204.

[2] 'Géologie de la Russie d'Europe,' loc. cit.

1852. Ammonites reticulatus (pars), *C. G. Giebel.* Fauna der Vorwelt, vol. iii, p. 471.

1854. Goniatites Gibsoni, jugosus, reticulatus, *J. Morris.* Cat. Brit. Foss., 2nd ed., pp. 303, 304.

1855. Aganides reticulatus, *F. M'Coy.* Brit. Pal. Foss., p. 566.

: 1855–57. Goniatites Gibsoni, reticulatus, *J. Kelly.* Journ. Geol. Soc. Dublin, vol. vii, p. 7.

1860. — crenistria, *W. H. Baily.* Expl. Sheet 142 Geol. Surv. Ireland, pp. 11, 12, figs. 2 *a—h, j, l, m* (? *i, k*).

1862. Gibsoni, reticulatus, *J. W. Salter.* Geology of the Country around Bolton-le-Moors (Mem. Geol. Surv.), pp. 34, 35.

1864. Geology of the Country around Oldham (Mem. Geol. Surv.), p. 59.

1876. *J. Armstrong, J. Young, and D. Robertson.* Cat. Western Scottish Fossils, p. 58.

1884. Munsteroceras reticulatum, *A. Hyatt.* Proc. Boston Soc. Nat. Hist., vol. xxii, p. 326.

1888. Goniatites Gibsoni, jugosus, reticulatus, *R. Etheridge.* Brit. Foss., vol. i, Palæozoic, pp. 311, 312.

Gastrioceras Gibsoni, *M. Tzwetaev.* Mém. Com. géol. St. Pétersbourg, vol. v, No. 3, p. 1.

1893. Goniatites jugosus, *H. Bolton.* Cat. Types and Figured Specimens, Manchester Museum, p. 15.

1897. Glyphioceras reticulatum, *A. H. Foord and G. C. Crick.* Cat. Foss. Ceph. British Museum, pt. 3, p. 193, fig. 94 (suture-line).

1898. Goniatites crenistria, *A. McHenry and W. W. Watts.* Guide to the Collection of Rocks and Fossils belonging to the Geological Survey of Ireland, p. 124.

1899. — reticulatus, *James Spencer.* Proceed. Yorkshire Geol. and Polytech. Soc., new ser., vol. xiii, pt. 4, p. 391.

1901. Glyphioceras reticulatum, *Wheelton Hind and J. A. Howe.* Quart. Journ. Geol. Soc., vol. lvii, p. 349, etc.

1902. *Wheelton Hind.* Brit. Assoc. Adv. Sci., Glasgow, 1901, p. 296, "Life-zones in the British Carboniferous Rocks."

[Not 1854. Goniatites reticulatus, *F. A. Roemer.* Palæontographica, vol. iii, pl. xiii, fig. 31.]

Description.—"Shell discoidal, somewhat inflated, with four or five angulated constrictions on the outer whorl; greatest thickness at the edge of the umbilicus, nearly one-half of the diameter of the shell; height of outer whorl a little more

than one-half of the diameter of the shell. Whorls six or seven; inclusion almost complete; umbilicus about one-fourth of the diameter of the shell in width, with angular margin and sloping sides. Whorl obtusely sagittate in section, rather higher than wide; indented to a little more than one-half of its height by the preceding whorl; periphery subangular; sides feebly convex, with an obtuse spiral ridge near their centre; inner area rather narrow, well defined, flattened, sloping towards the umbilicus. Body-chamber occupying a complete whorl. Chambers rather shallow. . . . Test thin, delicately reticulate; the transverse striæ very finely crenulate, strongly arched forward near the periphery, and forming thereon a deep broad sinus; its inner surface with angulated thickenings, producing constrictions on the internal cast. Initial chamber small, transversely ovoid."

"Immature forms differ from the adult in being less inflated and in having a more convex periphery. The constrictions are scarcely visible on the test, but are well marked on the internal cast. By breaking back and by sectioning adult examples we have been able to satisfy ourselves that the young stages are what have been named *Gon. Gibsoni*; these not uncommonly have a slightly sulcated periphery (more conspicuous in an internal cast), and have been described as *Gon. jugosus*."

"Shell attaining a diameter of about 45 mm." ('Cat. Foss. Ceph. Brit. Mus.,' loc. cit.)

Affinities.—The relationship of the present species to *Glyphioceras* (*Beyrichoceras*) *excavatum* is referred to under the description of that species; it has also some affinities with *G.* (*B.*) *Davisi*, Foord and Crick,[1] but the latter has a more inflated form and an acutely angular periphery.

Remarks.—This species is represented in the "Griffith Collection" only by some crushed fragments in shale, but the characteristic ornamentation sufficed for its determination. The specimens are, however, not in a condition to serve for illustration.

Localities.—Mullaghtinny (Cloger), county of Tyrone; Doon, Mount Phelim, one mile south-west of Kilfendra, county of Clare; Paget Priory, five miles north of Maynooth—a local name,—county of Meath (the specimen from the last-named locality is labelled "*Goniatites Gibsoni*"); Rathcahill, near Abbeyfield, county of Limerick.

GLYPHIOCERAS (BEYRICHOCERAS) SUBRETICULATUM, sp. nov. Plate XLIX, figs. 6 *a*, *b*, 7 *a*—*d*.

Description.—Shell (young?) discoidal, compressed, umbilicated; greatest thickness at the edge of the umbilicus, about one-half of the diameter of the shell;

[1] 'Cat. Foss. Ceph. British Museum,' part iii, 1897, p. 198, figs. 95 *a*—*c*.

height of outer whorl in the same proportion. Number of whorls unknown; inclusion nearly complete. Umbilicus probably rather deep, almost exactly one-fourth of the diameter of the shell in width, with a subangular margin and steep inner area. Whorl semi-oval in section, height and width nearly equal; indented to about one-third of its height by the preceding whorl. Periphery narrowly convex, separated from the sides by an obscure ridge. Sides flattened. Extent of body-chamber unknown. Chambers shallow. Suture-line as in Pl. XLIX, fig. 7 *d*. Test covered by a multitude of delicate, regular, crenulated lines, which bifurcate near the umbilical margin. At intervals one or two of the lines are elevated slightly above the others, giving the appearance of slight ridges where this occurs. The lines are distinctly sigmoid in crossing the sides of the shell. Starting from the umbilical margin they curve slightly backwards at about the middle of the sides, then curve strongly forwards and again backwards upon the periphery, where they make a deep linguiform sinus. Faint spiral lines, a little stronger near the periphery, cover the whole of the test. Two broad and shallow constrictions crossing the sides and periphery in the same direction as the crenulated lines appear upon the cast. No trace of constrictions can be seen where the shell is present.

Dimensions.

	Specimen in the Dublin Mus. Sci. and Art (Geol. Surv. Coll.), No. 845 C.
Diameter of shell	23·0 mm.
,, umbilicus . . .	5·5 ,,
Height of outer whorl . . .	12·0 ,,
,, above preceding whorl . . .	8·0 ,,
Thickness at umbilical margin . .	11·0 ,,

Affinities.—From the nature of the ornaments this species would appear to belong to the *reticulatum* group, but it is a much more compressed shell and the reticulations much finer than in *Glyphioceras (Beyrichoceras) reticulatum* itself; the umbilicus is also much smaller in the present species than in the latter. The suture-line is characterised by the obtuse form of the lateral lobe, at least in the young shell, the suture of which is figured (Pl. XLIX, fig. 7 *d*). When the septa are not seen the ornamentation of the shell will suffice for the recognition of the species. Another specimen from the same locality, and I believe the same band of rock, is doubtfully referred to this species. It is a cast of the greater part of the body-chamber, with the septa, which are somewhat eroded, occupying about one-third of the whorl. The ornamentation is obscurely seen upon the cast; it resembles that of the present species. A very fine keel extends along the median line of the periphery (Pl. XLIX, fig. 6 *b*).

Locality.—Foynes Island, county of Limerick.

GLYPHIOCERAS (BEYRICHOCERAS) BILINGUE, *J. W. Salter*, sp. Plate XLIX, fig. 1.

1864.	GONIATITES BILINGUIS, *J. W. Salter.*			Mem. Geol. Surv., Geology of the Country around Oldham, p. 60, figs. 14 *a*—*c*.
1885.	—	—	*R. Etheridge.*	Mem. Geol. Surv., Geology of the Country around Rhyl, Abergele, and Colwyn, p. 17.
1888.	—	—	—	Brit. Foss., vol. i, Palæozoic, p. 311.
1896.	—	—	*H. Bolton.*	Trans. Manchester Micro. Soc. for 1895, pp. 130, 134.
1897.	GLYPHIOCERAS BILINGUE, *A. H. Foord and G. C. Crick.*			Cat. Foss. Ceph. British Museum, pt. 3, p. 192, fig. 93 (suture-line).
1901.	—	—	*Wheelton Hind and J. A. Howe.*	Quart. Journ. Geol. Soc., vol. lvii, p. 356, etc.
1902.	—	—	*Wheelton Hind.*	Brit. Assoc. Adv. Sci., Glasgow, 1901, p. 296, "Life-zones in the British Carboniferous Rocks."
1903.	—	—	—	Ibid., Belfast, 1902, p. 218, etc., "Life-zones in the British Carboniferous Rocks."

Description.—The following is the description of this species contained in the 'Catalogue of Fossil Cephalopoda, British Museum,' pt. 3, 1897, and is here transcribed because it is based upon much more complete material than I have at my disposal for describing the species:—"Shell compressed, involute; greatest thickness at the edge of the umbilicus rather more than four-ninths of the diameter of the shell; height of outer whorl nearly one-half of the diameter of the shell. Whorls (? number); inclusion almost complete; umbilicus infundibuliform, with angular margin and sloping sides, nearly one-fourth of the diameter of the shell in width. Whorl bluntly sagittate in section, a little higher than wide; indented to about two-fifths of its height by the preceding whorl; periphery convex, a little flattened; sides feebly convex, with a double spiral furrow near the periphery, their portion internal to the furrow flattened; inner area distinctly marked off, narrow, sloping towards the umbilicus. Body-chamber occupying a complete whorl; aperture with a projecting tongue-like lobe on either side near the periphery, and a deep broad hyponomic sinus. Chambers rather shallow. . . . Test thin, its surface delicately reticulate; transverse striæ very finely crenulate, strongly arched forward at the double concentric groove and forming a deep broad sinus on the periphery; longitudinal striæ very feeble."

"All the examples of this species in the Jermyn Street Museum are either very

much crushed or are merely impressions on the surface of pieces of shale occurring in the Millstone Grit. No specimen can there be found so well preserved as represented in Salter's figure, and we have not seen the suture-line in any of these examples. There are two forms: one with a rather open umbilicus exposing the edges of the inner whorls, on which, as well as on the inner edge of the outer whorl, the fine ornaments of the test are accompanied by small folds; the other with a much finer ornamentation, and a smaller and infundibuliform umbilicus. The specimens in the National Collection agree with the latter. Shell attaining a diameter of 56 mm." The specimens in the British Museum are from Halifax, Yorkshire.

Dimensions.

	Specimen from Caher Lane in the Dublin Mus. Sci. and Art (Geol. Surv. Coll., No. 2208 C).
Diameter of shell (approximately) . .	28 mm.
„ umbilicus . . .	6 „
Height of outer whorl . . .	14 „

Affinities.—On the whole this species seems to be most nearly allied to *Glyphioceras* (*Beyrichoceras*) *reticulatum*, but the ornamentation in the latter is much coarser than it is in *G. bilingue*, though, as remarked in the description of *G.* (*B.*) *Davisi*, it is of a similar character. The umbilicus is smaller than that of the specimens described in the 'Catalogue of Fossil Cephalopoda, British Museum,' p. 193, but this may be only an individual variation.

Salter's figure (loc. cit.) has all the appearance of being a "restoration," and there is apparently no individual specimen in the Jermyn Street Museum which can be recognised as the original of it. The description given by Salter has, however, sufficed to distinguish the species, the "exaggerated processes on the edge of the mouth" causing the "double concentric furrow near the periphery," making it easily recognisable. This feature in it is seen in a milder form in the larger of Phillips's figures of *G. reticulatum* ('Geol. Yorks,' ii, pl. xix, fig. 27). It is to be observed that there are no constrictions on the shell in the present species.

Localities.—Caher Lane (No. 2208 C), and Rathcahill (No. 3429 C), near Abbeyfield, county of Limerick.

Glyphioceras (Beyrichioceras) Davisi? *A. H. Foord and G. C. Crick.* Plate XLIX, fig. 4.

1897. Glyphioceras Davisi, *A. H. Foord and G. C. Crick.* Cat. Foss. Ceph. British Museum, pt. 3, p. 198, figs. 95 *a*—*c*.

Description.—Shell somewhat inflated, umbilicated, greatest thickness at the edge of the umbilicus; height of outer whorl about one-half of the diameter of the shell.

Whorls probably five or six; inclusion almost complete; umbilicus about one-third of the diameter of the shell in width, the sides steep, the margin subangular, exposing the edges of the inner whorls; inner area well defined, rather narrow, almost at right angles to the plane of symmetry. Test thin, the ornamentation consisting of regular, distinctly crenulated transverse striæ, which bifurcate shortly after leaving the margin of the umbilicus; these take a nearly straight course for a short distance, then bend backwards, then more strongly forwards. (The peripheral area is not preserved.) Faint spiral lines are seen on the sides of the shell, which nearer the periphery become as prominent as the transverse striæ, and produce a reticulate structure. At about two-thirds of the distance across the lateral area there is a distinct rounded spiral ridge, which on the side nearest to the periphery merges in a depression in which the transverse striæ make their strongest forward curvature. No constrictions are to be seen. The suture-line is unknown.

Affinities.—The evidence in favour of this species being identical with *Glyphioceras Davisi*, Foord and Crick, is not quite conclusive, I have therefore put a note of interrogation after the name. The doubt arises from the absence of the suture-line and other imperfections in the only specimen that has come to my notice. The general character of the ornamentation, crenulated and bifurcating striæ, is well brought out in fig. 7 *c*, Pl. XLIX—an allied species.

Remarks.—This species forms one of a group which includes *Glyphioceras* (*Beyrichoceras*) *reticulatum*, *G.* (*B.*) *subreticulatum*, and *G.* (*B.*) *bilingue*. In all these the ornaments of the shell are strikingly similar in their character,—that is, they consist of crenulated, transverse, often bifurcating striæ, with more or less strongly developed spiral striæ crossing them, the latter always strongest in the peripheral region. This species was found at Rathcahill associated in the same beds with *G.* (*B.*) *reticulatum* and *G.* (*B.*) *pulchellum*.

Locality.—Rathcahill, near Abbeyfield (No. 3435 C), and Foynes Island (No. 813 C, pars), county of Limerick.

Glyphioceras (Beyrichoceras) cordatum, *G. C. Crick*. Plate XLVII, figs. 2 *a*—*c*.

1899. Glyphioceras cordatum, *G. C. Crick*. Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 445, fig. 10.

Description.—Shell discoidal, rather inflated, lenticular, narrowly and deeply umbilicated; greatest thickness at a short distance from the umbilical margin, a little more than one-half of the diameter of the shell; height of outer whorl a little less than one-half of that diameter. Whorls probably not less than four, but the exact number cannot be stated owing to the outer one being imperfect. Inclusion

about five-sixths; umbilicus very deep and step-shaped, with subangular margins and steep sides, the depth from the edge of the outer whorl about 28 mm.; about one-fourth of the diameter of the shell in width. Whorl distinctly cordate in cross-section in the region of the aperture; a little wider than high; indented to nearly one-half of its height by the preceding whorl. Periphery narrowly convex, its boundaries imperfectly defined upon the cast by an obtuse and obscure ridge on each side of it; these ridges are not seen where the shell is present. The periphery becomes acute towards the aperture, when all trace of the ridges disappears. The sides are slightly convex, with a faint obtuse ridge, also upon the cast only, at about three-fifths of the width of the side from the edge of the umbilicus, becoming obsolete, as is the case with the peripheral ridges, on the anterior part of the body-chamber. Umbilical zone well defined, rather narrow, nearly perpendicular to the plane of symmetry of the shell. Body-chamber occupying at least the whole of the last whorl, probably exceeding this limit; aperture not preserved, but the lines of growth upon the test indicate that the peristome was furnished with a prominent lateral crest and a deep and narrow hyponomic sinus. Chambers rather shallow. Suture-line as in Pl. XLVII, fig. 2 *c*. Test nearly smooth, with lines of growth which have a nearly radial direction on the inner portion of the lateral area, then bend forwards and finally backwards to form the deep and narrow hyponomic sinus upon the periphery. The cast, especially in the anterior region of the body-chamber, shows distinct traces of the faint lines of growth that ornament the test.

Dimensions.

	Type specimen in Museum of Science and Art, Dublin.
Diameter of shell . . .	116·5 mm.
,, umbilicus (edge to edge) .	28·5 ,,
,, ,, (suture to suture) .	26·0 ,,
Height of outer whorl (about) .	51·5 ,,
,, above preceding whorl (about) .	27·5 ,,
Thickness at umbilical margin .	56·0 ,,

The measurements which relate to the diameter of the shell must be taken as approximate, as the shell has been rendered somewhat elliptical by rock pressure. The longer of the two diameters has been given in the dimensions of the umbilicus, the shorter in those of the shell, as a large piece of the outer whorl has been broken off, making measurements of the longer diameter very difficult to effect.

Affinities.—Mr. Crick (loc. cit.) observes that "this species is evidently closely related to such forms as *Glyphioceras reticulatum*, J. Phillips, sp.,[1] and *Glyphioceras Davisi*, Foord and Crick."[2]

[1] 'Geol. York.,' pt. ii, 1836, p. 235, pl. xix, figs. 26—32. Also 'Cat. Foss. Ceph. British Museum,' pt. iii, 1897, p. 193. [2] 'Cat. Foss. Ceph. British Museum,' pt. iii, 1897, p. 198, fig. 95.

This relationship shows itself in the case of *G.* (*B.*) *Davisi* in the acute periphery, and in both species in the presence of the lateral crest indicated in the ornaments of the test. The deep and angular-margined umbilicus in *G.* (*B.*) *reticulatum* and *G.* (*B.*) *Davisi* is also paralleled in *G.* (*B.*) *cordatum*.

Remarks.—The only individuals of this species known to me, two in number, were obtained in the great quarries of Little Island which overlook one of the lower reaches of the river Lee, about four miles below the city of Cork, locally known as Lough Mahon. Both specimens are distorted, the one whose dimensions are given above much less so than the other, which is stretched out into a long ellipse, whose greater diameter would be at least double that of the normal diameter of the shell. Such is the condition of many of the fossils in the Carboniferous rocks of the south of Ireland, these rocks having undergone severe pressure, which has thrown them into numerous folds and dislocations, involving the distortion of the fossils contained in them.

Locality.—Little Island, near Cork.

GLYPHIOCERAS (BEYRICHOCERAS) PULCHELLUM, sp. nov. Plate XLIX, fig. 5.

Description.—Shell rather small, somewhat inflated, umbilicated; height of outer whorl rather more than half the diameter of the shell. Whorls apparently few in number. Inclusion nearly complete. Umbilicus one-fifth of the diameter of the shell, deep, infundibuliform, with steep sides and subangular margin. Whorl bluntly sagittate in section, apparently a little wider than high, but the exact proportions cannot be determined, as only one-half of the shell is free from the rock; indented to about three-eighths of its height by the preceding whorl. Periphery narrowly rounded. Lateral area regularly convex, appearing in profile as a very broad and spreading arch; becoming a little depressed in the upper half near the aperture. Test ornamented with very fine but perfectly distinct thread-like lines, apparently with crenulations; proceeding from the umbilicus they pursue at first a nearly straight course, but soon make a slight curve backwards, then curving boldly forward they pass over the periphery in a strong backwardly directed curve, thus forming a deep sinus in that region. Towards the aperture the anteriorly directed curve becomes narrower and more tongue-like in form, and the lines have here a tendency to form little bundles, which cause them to stand out more prominently. Two narrow and shallow constrictions, which conform in direction to the lines of the ornamentation, are developed upon the test. Very faint spiral lines are seen covering the test all over. (It must not be supposed that these lines produce the effect of reticulation: they can only be seen with a lens; the transverse lines are easily discernible without such aid.) Body-chamber and septa unknown.

Dimensions.

	Specimen from Rathcahill, in Science and Art Mus., Dublin (Geol. Surv.), No. 3450 C.
Diameter of shell	30 mm.
,, umbilicus	6 ,,
Height of outer whorl	15 ,,

Affinities.—This species seems to have affinities with the *reticulatum* group, and in particular with *G.* (*B.*) *reticulatum* itself. It differs from this species in its much smaller umbilicus, and in the character of its ornaments, the delicacy of which is remarkable; the transverse striæ are in fact much finer than those of *G.* (*B.*) *reticulatum*, and the spiral ones so conspicuous in the latter are only feebly developed in the present species, so as to be scarcely perceptible without the assistance of a lens. The contrast between the two species as respects their ornamentation, etc., is well represented in figs. 2 *a* and 5 of Pl. XLIX.

Locality.—Rathcahill, near Abbeyfield, county of Limerick.

GLYPHIOCERAS (BEYRICHOCERAS) SPIRALE, *J. Phillips*, sp. Plate XLIX, fig. 9.

1841.	GONIATITES	SPIRALIS, *J. Phillips.*	Pal. Foss. Cornwall, Devon, and West Somerset, p. 121, pl. l, fig. 233.
1843.	—	GRANOSUS, *J. E. Portlock.*	Geology of Londonderry, p. 407, pl. xxix A, fig. 9.
—	—	STRIATUS, *F. A. Roemer.*	Verstein. Harzgeb., p. 34, pl. ix, figs. 11 *a*, *b*.
—	—	SPIRALIS, *J. Morris.*	Cat. Brit. Foss., p. 180.
—	—	GRANOSUS, *J. Morris.*	Ibid., p. 179.
1844.	—	SPIRALIS, *F. M'Coy.*	Synops. Carb. Foss. Ireland, p. 16.
1848.	—	— *H. B. Bronn.*	Geschich. d. Natur, vol. iii, p. 544.
1852.	AMMONITES	SPIRALIS, *C. G. Giebel.*	Fauna der Vorwelt, vol. iii, pt. 1, p. 454.
1854.	GONIATITES	SPIRALIS, *J. Morris.*	Cat. Brit. Foss., 2nd ed., p. 304.
—	—	GRANOSUS, *J. Morris.*	Ibid., p. 303.
1855–7.	—	SPIRALIS, *J. Kelly.*	Journ. Geol. Soc. Dublin, vol. vii, p. 7.
—	—	GRANOSUS, *J. Kelly.*	Ibid., vol. vii, p. 7.
1860.	—	SPIRALIS, *W. H. Baily.*	Geol. Surv. Ireland, explan. of sheet 101 of the Maps, p. 13.
1862–4.	—	— *F. A. Roemer.*	Palæontogr., vol. ix, p. 11, pl. iv, figs. 2 *a*—*c*.
1864.	—	— *J. W. Salter.*	Geology of the Country around Oldham (Mem. Geol. Surv.), p. 59.
? 1878.	—	BAYLEI, *A. Leymerie.*	Descrip. géol. et paléont. Pyrénées, p. 747, pl. c, fig. 4.
1888.	—	SPIRALIS, *R. Etheridge.*	Brit. Foss., vol. i, Palæozoic, p. 313.

1897.	Glyphioceras spirale,	*A. H. Foord and G. C. Crick.*		Cat. Foss. Ceph. British Museum, pt. 3, p. 210, fig. 101 (suture-line).
1901.	—	—	*Wheelton Hind and J. A. Howe.*	Quart. Journ. Geol. Soc., vol. lvii, p. 356, etc.
1902.	—	—	*Wheelton Hind.*	Brit. Assoc. Adv. Sci., Glasgow, 1901, p. 289, etc., "Life-zones in the British Carboniferous Rocks."
1903.	—	—	—	Ibid., Belfast, 1902, p. 217, "Life-zones in the British Carboniferous Rocks."

Description.—Shell discoidal; whorls broad and apparently almost completely overlapping each other, thus leaving a very small umbilicus. Test ornamented with numerous fine, regular, spiral lines, which, so far as can be ascertained, are of a delicate thread-like character, varying according to the size of the specimen from ·5 mm. to 1 mm. apart. These are crossed by a multitude of extremely delicate lines which in cutting the former produce in them a granular appearance, but so fine as to be scarcely visible to the naked eye.

Dimensions.

	Large specimen from Summer Hill, County of Meath, in Dublin Mus. Sci. and Art.	Specimen figured, Pl. XLIX, fig. 9.
Diameter of shell	61 mm.	33·0 mm.
„ umbilicus	—	3·5 „
Height of outer whorl	31 „	15·0 „

These dimensions must be taken as only approximately correct, as the specimens are crushed perfectly flat.

The true form of this species has not been preserved in the fissile shales in which it occurs in this country, nor yet in England, as we learn from Phillips,[1] and recently from Wheelton Hind; but F. A. Roemer[2] figures an uncrushed specimen which indicates a shell of a somewhat compressed form, having the following measurements (derived from the figure) :—diameter of shell 24 mm., height of outer whorl 12 mm., diameter of umbilicus 5 mm. Thickness of shell at umbilical margin 10 mm.

Roemer states that the number of spiral lines upon the last whorl is about fifty, and that the spaces between them are covered with much finer transverse lines.

Affinities.—Fragments of *Glyphioceras* (*Beyrichoceras*) *striatum* with the test well preserved have been mistaken for the present species; it would seem, therefore, that in respect to ornamentation there is some resemblance between the two species;

[1] Pal. Foss. Cornwall, Devon, and West Somerset, 1841, p. 121.

[2] Palæontographica, 1862–4, vol. ix, pl. iv, figs. 2 *a*—*c*.

but it is little more than superficial. In *G.* (*B.*) *striatum* the shell is more inflated than in *G.* (*B.*) *spirale*, and the spiral lines in the latter are wider apart than they are in the former. There is considerable difference also in the form of the suture-line in the two species. But although distinguishable even in fragments there can hardly be any question as to their close relationship. Spiral ornamentation seems to be as rare among the Goniatites as the corresponding longitudinal ornamentation is among the straight-shelled Nautiloidea (Orthoceratites), or spiral ornaments in the coiled ones excepting in the younger stages of growth.

The "*Goniatites*" *granosus* of Portlock appears to represent only a particular state of preservation of *Glyphioceras spirale* in which the transverse lines are more conspicuous than they are in the casts of the shell usually met with. It is therefore included among the synonymy of the latter as in the 'Catalogue of Fossil Cephalopoda, British Museum,' part iii.

Remarks.—The slaty character of the deposits in which this species occurs has been fatal to its good preservation, and it appears only in the shape of casts crushed perfectly flat between the thin papery layers of the rock. Fragments of the test with its fine thread-like lines are sometimes seen scattered near the crushed shells, but it is usually met with in the condition of casts consisting of a series of regular, parallel incised lines crossed by curved transverse lines scarcely visible to the naked eye. The figure of this species on Pl. XLIX (fig. 9) shows very well the condition in which the species usually occurs.

The largest complete specimen measures 55 mm. in diameter. This is from Summer Hill Quarry in the county of Meath. A fragment (cast) measures 52 mm. from the centre of the umbilical cavity to a point near but not at the periphery; this represents a specimen which may have measured as much as 80 mm. in diameter. It comes from the same county as the other, from near Trim.

Localities.—Loughshinny, county of Dublin (No. N. 4299; V. 4301); Summer Hill and near Trim (No. 37 K), county of Meath; Killorglin, county of Kerry (Dingle Bay) (No. 3804 C).

Sub-genus Muensteroceras,[1] *Hyatt*, 1883.

Glyphioceras (Muensteroceras) crassum, sp. nov. Plate XLII, figs. 10 *a*—*c*.

Description.—Shell of medium size, discoid, thick, somewhat compressed, the greatest thickness at the umbilical margin, rather more than two-fifths of the diameter of the shell; height of the outer whorl about three-fifths of the diameter

[1] For definition of this sub-genus see Appendix, p. 219.

of the shell. Inclusion of the whorls nearly complete; umbilicus small. Whorl semi-elliptical in cross-section, somewhat higher than wide, indented to about one-third of its height by the preceding whorl. Periphery rather broadly rounded, but with some tendency to flattening. Umbilical zone indistinct, merging with a slight degree of convexity in the sides of the shell. Extent of body-chamber unknown. Aperture unknown. Chambers of moderate depth, peripheral lobe of the suture-line very deep, with subparallel sides (Pl. XLII, fig. 10 *c*). Test apparently marked only with lines of growth, but its bad preservation precludes any detailed description of it.

Dimensions.

	Specimen in the Museum of Science and Art, Dublin (Geological Survey Collection, No. 547).
Longer diameter of shell (approximately) .	. 75 mm.
„ „ umbilicus (about) .	. 12 „
Height of outer whorl (about) . .	. 45 „
Thickness at umbilical margin (about) .	. 35 „

These measurements are only rough approximations, as the shell is much distorted.

Affinities.—In the form of the suture-line this species closely resembles *Glyphioceras parallelum*, J. Hall, sp.,[1] especially in the length of the peripheral lobe and its nearly parallel sides. Hall's species was selected by Hyatt as the type of *Muensteroceras*.

Remarks.—Only one individual assignable to the present species has come under my notice. The thick form of the shell led me at first to regard it as closely allied to *G.* (*B.*) *obtusum*, but the suture-line when developed contradicted this view, and pointed to affinities with the group of species of which *G.* (*M.*) *parallelum*, J. Hall, sp., is the typical form.

Locality.—Ballinacarriga, county of Limerick.

GLYPHIOCERAS (MUENSTEROCERAS) ELLIPSOIDALE, *G. C. Crick.* Plate XLIII, figs. 1 *a*—*c*.

1899. GLYPHIOCERAS ELLIPSOIDALE, *G. C. Crick.* Ann. Mag. Nat. Hist., ser. 7, vol. iii, p. 499, fig. 14.

Description.—Shell subglobose, somewhat compressed at the sides, with rather broadly rounded periphery; umbilicated; greatest thickness at the umbilical margin, about four-sevenths of the diameter of the shell; height of outer whorl nearly three-

[1] Thirteenth Rep. New York State Cabinet Nat. Hist., 1860, p. 101, figs. 13, 14.

sevenths of the same. Number of whorls not known; inclusion about two-thirds. Umbilicus deep, with steep, nearly vertical sides and subangular margin, exposing the edges of the inner whorls, about two-sevenths of the diameter of the shell in width. Whorl very distinctly semi-elliptical in cross-section, height about three-fourths of the width; indented to nearly one-third of its height by the preceding whorl. Sides slightly covex, somewhat flattened near the umbilicus; umbilical zone narrow, slightly concave, nearly perpendicular to the plane of symmetry of the shell. Body-chamber occupying the whole of the last whorl; peristome with a widely curved lateral crest and broad and deep hyponomic sinus. Test smooth, with faint lines of growth near the aperture.

Dimensions.

	Type specimen from Kildare, in the Museum of Science and Art, Dublin.
Diameter of shell	83·0 mm.
„ umbilicus (edge to edge) .	23·5 „
„ „ (suture to suture) .	20·0 „
Height of outer whorl . . .	36·0 „
„ above preceding whorl . . .	25·0 „
Thickness at umbilical margin . .	47·0 „

Affinities.—The only species which resembles the present one in any marked degree is that which I have called *G.* (*M.*) *obesum*, which, being figured upon the same plate, can be readily compared. The form of the shell in each is considerably inflated, and in both the peripheral lobe of the suture-line has the subparallel sides characteristic of *Muensteroceras*. The test in both is smooth. In cross-section, however, the whorl in *G.* (*M.*) *ellipsoidale* is broadly arched above; in *G. obesum* it is narrower as well as being distinctly flattened—at least in the region of the body-chamber.

There is not very much difference between them in their umbilical characters. Allowing for the distortion in the specimen representing *G.* (*M.*) *obesum*, the umbilicus in this species is relatively smaller than that of *G.* (*M.*) *ellipsoidale*. Its more inflated and smooth shell and larger umbilicus suffice to distinguish the present species from *G. striatum*, J. Sow.

Remarks.—Mr. Crick[1] refers a specimen in the British Museum (No. C. 294) to the present species, but with some doubt; it is from the Carboniferous Limestone of Rathkeale.

Localities.—Kildare (exact locality in the county unknown); Little Island, near Cork; (?) Rathkeale, county of Limerick.

[1] Loc. cit., p. 450.

Glyphioceras (Muenstéroceras) obesum, sp. nov. Plate XLIII, figs. 3 *a*—*c*.

Description.—Shell subglobose, rendered elliptical by pressure, the longer (antero-posterior) diameter measuring 112 mm., the shorter 100 mm.; greatest thickness at the umbilical margin, about one-half of the shorter diameter of the shell; height of outer whorl rather less than one-half of that diameter; inclusion almost complete. Outer whorl indented to about two-fifths of its height by the preceding whorl. Umbilicus proportionally small, about one-fifth of the smaller diameter of the shell, with subangular margin. Periphery at first very broadly rounded, but becoming subtruncate in the adult shell as the aperture is approached. Inner area narrow, slightly concave.

Body-chamber occupying at least an entire volution. Chambers shallow. Suture-line as in Pl. XLIII, fig. 3 *c*.

Test quite smooth, with only faint lines of growth, which may be seen here and there proceeding from the umbilicus. No distinct indications of constrictions can be seen, but the surface of the cast is badly preserved and eroded in places, and they may thus have been obliterated.

Dimensions.

	Large specimen in the Collection of Mr. Joseph Wright, F.G.S., Belfast.	
Diameter of shell (long)	. 112 mm.	. (short) 100 mm.
„ umbilicus (long)	. 21 „	. „ 18 „
Height of outer whorl	. 48 „	
„ above preceding whorl	. 32 „	
Thickness at umbilical margin	. 53 „	

Affinities.—*Glyphioceras* (*Muenstéroceras*) *ellipsoidale* has been compared with the present species under the description of the former.

Remarks.—The large individual representing the present species was obtained in the quarries of Little Island, and forms part of Mr. Joseph Wright's small but interesting collection from the neighbourhood of Cork.

Locality.—Little Island, near Cork.

Genus Gastrioceras, *Hyatt*, 1883 (emend. Karpinsky, 1890).

Gastrioceras circumnodosum, sp. nov. Plate XLIX, figs. 10, 11.

Description.—Shell rather small, inflated, umbilicated; greatest thickness at the margin of the aperture; height of outer whorl about one-half of the diameter of the

shell. Whorls rather numerous, their number not precisely ascertainable; probably six or seven. Inclusion nearly complete. Umbilicus rather more than one-third of the diameter of the shell in width, with steep sides, the edges subangular and tuberculated, only the edge of the inner whorls exposed. Whorl semilunate in section, considerably wider than high, but the exact proportions cannot be given; indented to nearly one-third of its height by the preceding whorl. Periphery very broadly arched, merging in the lateral area. Umbilical walls steep, with subangular margin, bearing a single row of tubercles, which give rise to fine lines crossing the periphery, the nature of which cannot be very distinctly made out owing to the weathering of the fossil, but they appear to be fairly regular, raised lines, probably varying in prominence, crossing the periphery, with a very slight curvature, resembling the lines ornamenting the test in *Gastrioceras Listeri*, a well-known and closely related species. The tubercles are somewhat lengthened in a direction at right angles to the spiral of the shell, or, in other words, they radiate towards the centre of the umbilical cavity.

Body-chamber and septa unknown.

Dimensions.

	Plaster cast of the largest of the original moulds. Firoda (Kilkenny). Dublin Mus. Sci. and Art (Geol. Surv. Coll.).
Diameter of shell . . .	31 mm.
„ umbilicus . . .	11 „
Height of outer whorl . .	15 „
„ above preceding whorl (about) .	10 „
Thickness at umbilical margin (about) .	20 „

Affinities.—There are several species with which the present one may be compared. The most nearly related are *Gastrioceras Listeri* [W. Martin], J. de C. Sowerby, sp.;[1] *G. carbonarium*, von Buch, sp.; and *G. coronatum*, Foord and Crick. From the first of these *G. circumnodosum* is readily distinguished by its more contracted umbilicus and proportionately narrower periphery; it is certainly very closely allied to this species. From *G. carbonarium* the present species differs in its narrower and deeper umbilicus and its much more inflated form. *G. coronatum* is an allied form, but it has in all stages of growth more depressed whorls, a broader and more flattened periphery, and a wider umbilicus than *G. circumnodosum*. *G. Jossæ*, de Vern., though resembling the present species in its encircling tubercles, has

[1] The numerous references to *G. Listeri* in the literature of Irish palæontology are erroneous. Several specimens in the Griffith Collection (Dublin Mus. Sci. and Art) also are labelled "*Goniatites Listeri*;" they are badly preserved specimens of *Pericyclus fasciculatus*, M'Coy. The labels referred to are probably the original ones, dating from M'Coy's 'Synopsis' (1844); the ink on them is much faded.

narrower and more numerous whorls and conspicuous spiral striæ, the latter being entirely absent in *G. circumnodosum*.

None of the species here compared with *G. circumnodosum* have been found up to the present time in Ireland.

In his important paper on the "Marine Fossils from the Coal Measures of Arkansas,"[1] J. Perrin Smith figures a specimen of *Gastrioceras* to which he does not assign any name, but which he describes as closely resembling *G. Marianum*, de Verneuil, in its young stage; while it is distinguished from *G. Marianum* in its adult stage by its narrower and more highly arched whorls. It appears to me that this species is intermediate in character, when mature, between *G. Listeri* and *G. Marianum*, and thus suggests affinities with *G. circumnodosum*, especially in the character of its ornaments, which consist of strong tubercles on the sides of the whorl; "which on the young stages are like those of *G. Marianum*, but on the adult form ribs reaching halfway from the umbilical shoulders to the ventral [peripheral] portion of the shell."

Mr. Perrin Smith describes *G. Marianum* in the same paper, giving figures of it in several stages of growth, up to a diameter of 54 mm. He recognises also in the same beds other "European Coal Measure forms not before known in America," viz. *Conocardium aliforme*, J. Sowerby, and *Pronorites cyclolobus*, J. Phillips.

Remarks.—In the absence of the suture-line the generic position of the present species has been determined in conformity with its close resemblance to well-known species of *Gastrioceras*, especially to *G. Listeri*, its affinities with which have just been pointed out.

The specimens upon which the present description is based are a series of empty moulds crowded together upon the surface of a fragment of carbonaceous shale. The weathering to which the rock has been subjected, though considerable, has not been so severe as to obliterate the coarser ornaments of the shells which originally occupied the moulds. Of these ornaments very distinct remains are imprinted upon the concave surfaces of nearly all the moulds. By filling the latter with plaster of Paris, and thus producing a cast of the surface of the slab, the form of the original shell was reproduced, the figures 10 and 11 on Pl. XLIX representing two of the best preserved surfaces. The shells vary in size from 2 mm. (some probably even smaller) to 31 mm., the diameter of the larger of the two specimens figured.

For the cast, which was made in the Dublin Museum of Science and Art, I am indebted to the kindness of Mr. G. H. Carpenter of that museum. I was much assisted further in the determination of the present species by Dr. Arthur Smith Woodward, F.R.S., who very kindly had casts made for me in the British Museum

[1] 'Proc. American Phil. Soc., Philadelphia,' vol. xxxv, Nov., 1896, No. 152, p. 262, pl. xx, fig. 1.

of *Gastrioceras Listeri*, *G. carbonarium*, and *G. coronatum*. These were all very serviceable for comparison with the Firoda specimens. I am much indebted also to Dr. Wheelton Hind, who sent me, from his large collection of British Carboniferous Fossils, specimens of *G. Listeri* and *G. carbonarium* in different stages of growth. Thus I had ample material for the study of the present species in its relationship with those above named.

Before concluding the description of this species it may not be out of place to refer briefly to the history of *Gastrioceras Listeri*. The chief interest of this centres in the question, which I had the opportunity lately of discussing with Dr. Hind, as to whether the species figured by Martin (1809) under the name "Ammonites Listeri" is the same species as the one afterwards figured by J. de C. Sowerby (1825) under the same name. The specimen figured by Martin is lost, therefore only the description and figure are available as evidence; the latter is decidedly unsatisfactory, and would only represent very roughly the characters of the ornamentation of the shell now known as *Gastrioceras Listeri*.

Another difficulty is that Martin always describes his species as occurring "in limestone tracts," and associates it with the species (of many of which he was himself the author) commonly occurring in, and characteristic of, the Mountain Limestone. It is well known that *Gastrioceras Listeri*, as universally recognised, belongs to formations of higher horizons than the latter, extending upwards to the Coal Measures.

Therefore, if Martin's name *Listeri* is still to be employed, it must be with the understanding that he was in error as to the horizon of his species. Though it is impossible to ascertain the exact locality whence Martin obtained his figured specimen and others—for he recognised the species as common,—the locality he vaguely referred to as "near Eyem [or Eyam] and Middleton" must have included rocks other than the Mountain Limestone, because, according to all experience, *G. Listeri* is not found at so low an horizon. It seems in the highest degree probable that the conjecture as to the stratigraphical origin of Martin's figured specimen quoted in the foot-note below is correct.[1]

In concluding these observations I may draw attention to a point which, however trifling it may seem, is worthy of note, namely, that in the hand-colouring of Martin's figure gold has been used to represent iron pyrites, a mineral of common

[1] Dr. Wheelton Hind, with characteristic enthusiasm, made a journey to Eyam and Middleton in April of this year (1903) to find out what rocks occur at those places, and he wrote to me giving me a sketch of the section there, showing the Mountain Limestone and the Pendleside Series in connection with it. "The Pendleside Series," he said, "contains thin black limestones in which *G. Listeri* occurs at other localities, so that it is probable the specimens [Martin's] were obtained from these beds, which were extensively worked in past years for lead veins which traversed them. These beds are above the Yoredale Series of Wenleysdale, in which *G. Listeri* has never yet been found."

occurrence in the Coal Measures, and present in all the specimens of *G. Listeri* I have met with from that horizon.

It is interesting to learn that Mr. James Perrin Smith, who has already done much good work in the embryology of the ammonoids, has made known the occurrence for the first time in America of *Gastrioceras Listeri*, associated with the nearly related species *G. carbonarium* and other Goniatites (*Glyphioceras* [*Sphenoceras*] *crenistria*, *G.* [*S.*] *striatum*, *G.* [*Beyrichoceras*] *calyx*).[1]

Locality.—Firoda, a townland and also a hamlet, two and a half miles north-west of Castlecomer, county of Kilkenny. (The specimen probably came from Firoda colliery, in the Kilkenny coal-field, but as the only locality given is "Firoda" it is not possible to allocate the specimen with precision.)

GASTRIOCERAS CIRCUMPLICATILE, sp. nov. Plate XLIX, figs. 12 *a*, *b*, 13.

Description.—Shell small, somewhat inflated, widely umbilicated; greatest thickness at the umbilical margin, about one-half of the diameter of the shell; height of outer whorl a little less than one-third of the diameter of the shell. The number of whorls probably five or six; inclusion so nearly complete that only the edges of the inner whorls are exposed. Umbilicus rather less than one-half of the diameter of the shell in width, deep, with subangular margin. Whorl semilunate in section, the height about three-fifths of the breadth; indented to about one-half of its height by the preceding whorl. Periphery broadly convex, the central part elevated into an obscure ridge; the narrow lateral area somewhat flattened, merging in the periphery. The ornamentation is very elaborate, and therefore difficult to give an adequate conception of by means of a description. It consists of a series of acute transverse ribs bordering the umbilicus and radiating therefrom, with a decided inclination towards the aperture. These ribs, which only extend to the width of the lateral area, give rise to a series of fine, raised, crenulated lines; the latter generally bifurcate twice in taking their course from the ribs across the periphery. The space between each set of bifurcating lines is filled up with from three to four simple lines, which do not, like the ribs, spring from the edge of the umbilicus, but from a point nearly on a level with the bifurcating lines just described. Thus there is a space left between the ribs devoid of any transverse lines; but this space is not quite smooth, for it is occupied by the fine spiral lines, here much stronger, that cover the whole test. The direction taken by the transverse lines upon the surface of the test is as follows:—Starting from the ribs, they curve first forwards and then more sharply backwards, forming a deep and some-

[1] "The Carboniferous Ammonoids of America," 'U.S. Geol. Surv.,' Mon. xlii, 1903, pp. 1—211, 29 plates. (Author's abstract in 'Geologisches Centralblatt,' Bd. iii, No. 13, p. 680.)

what broad sinus upon the periphery. Constrictions to the number of two or three to a whorl are present; these are rather inconspicuous upon the test, but make deep grooves in the cast, their course following that of the transverse lines.

Dimensions.

	Specimen from the "Cliffs of Moher" in the Dublin Mus. Sci. and Art (Geol. Surv. Coll.) (No. 4801 K).
Diameter of shell	22·0 mm.
,, umbilicus . . .	8·5 ,,
Height of outer whorl . . .	10·0 ,,
,, above preceding whorl . . .	7·0 ,,
Thickness at umbilical margin . . .	11·0 ,,

Affinities.—While there can be no doubt that a somewhat close relationship exists between the present species and *G. Marianum*, de Vern., the distinctness of the two species is made manifest by contrasting their proportions. These may be best realised if thrown into a tabular form:

Gastrioceras circumplicatile.	*Gastrioceras Marianum.*
Umbilicus about two-fifths of the diameter of the shell in width.	Umbilicus about three-fifths of the diameter of the shell in width.
Breadth and height of whorl nearly equal.	Breadth of whorl about two and a half times its height.
Thickness of the shell about one-half of its diameter.	Thickness of the shell about two-thirds of its diameter.
Height of outer whorl not quite one-half of the diameter of the shell.	Height of outer whorl about one-third of the diameter of the shell.

It is in the ornamentation of the shell that a striking similarity between the two species is noticeable, the most prominent feature being the elongated tubercles or plications decorating the margin of the umbilicus, from which arise the series of beautiful curved lines crossing the sides and peripheral area of the shell. These ornaments are common to both species, and give them a very distinctive character.

Except in the great width of the umbilicus and in its having marginal ornaments, there is no special resemblance between the present species and *G. Listeri*, nor between the latter and *G. Marianum*, as urged by de Verneuil.[1]

Karpinsky[2] compares *G. Marianum* with *G. Jossæ*, pointing out the more prominent character of the spiral ribs in the latter, and the greater width of the umbilicus in *G. Marianum*. But the marginal ornaments in *G. Jossæ* are much more prominent both in the young and in the adult than they are in *G. Marianum* and *G. circumplicatile;* they also early develop into strong tubercles. Neither in *G.*

[1] 'Géologie Russie d'Europe,' vol. ii, Paléont., 1845, p. 369, pl. xxvii, figs. 2 *a*—*c*.

[2] 'Mém. Acad. Imp. Sci. St. Pétersbourg' (7), vol. xxxvii, 1889, p. 49, pl. iv, figs. 2 *a*—*c*.

Marianum nor in *G. circumplicatile* does this take place; in these the plications encircling the umbilicus are not in any sense tubercular.

Under the name *Goniatites crenistria*, W. H. Baily[1] has confounded together at least three species from Foynes Island, including the one under description, and some of his figures can only with difficulty be identified with the specimens they are intended to represent.

Localities.—Lisdoonvarna (No. K. 495, Geol. Surv. Coll.), "Cliffs of Moher" (Nos. K. 1801 and 1802), county of Clare; Foynes Island (Nos. 824 C. and 842 C.), county of Limerick.

Family—Prolecanitidæ.

Genus Prolecanites, *Mojsisovics*, 1882 (emend. Hyatt, 1883).

Prolecanites compressus, *J. Sowerby*, sp. Plate XLVIII, figs. 4 *a*—*c*, 5 *a*, *b*, 6, 7, 8 *a*, *b*.

1813. Ellipsolites compressus, *J. Sowerby*. Min. Conch., vol. i, p. 84, pl. xxxviii.
1820. Ammonites Henslowi, *J. Sowerby*. Ibid., vol. iii, p. 111, pl. cclxii.
1821. — — — In Henslow's "Observations to Dr. Berger's Account of the Isle of Man," Trans. Geol. Soc., vol. v, pt. 2, p. 493.
1822. Ammonellipsites compressus, *J. Parkinson*. Introd. Foss. Org. Rem., pp. 164 and 233.
1825. Ceratites Henslowi, *de Haan*. Monog. Ammon. et Goniat., p. 157.
— Planites compressus, *de Haan*. Ibid., p. 93.
1828. Nautilus compressus, *J. Fleming*. Hist. Brit. Anim., p. 231.
— Ammonites Henslowi, *J. Fleming*. Ibid., p. 240.
1832. — — *L. von Buch*. Phys. Abhandl. d. k. Akad. d. Wissensch. zu Berlin für 1830, p. 171, pl. ii, fig. 1.
1836. Goniatites Henslowi, *J. Phillips*. Geology of Yorkshire, pt. 2, p. 236, pl. xx, fig. 39.
1842. — — *d'Archiac and de Verneuil*. Trans. Geol. Soc. (2), vol. vi, p. 329.
1843. — — *J. Morris*. Cat. Brit. Foss., p. 179.
— Nautilus compressus, *J. Morris*. Ibid., p. 182.
1844. Goniatites discus, *F. M'Coy*. Synops. Carb. Foss. Ireland, p. 13, pl. ii, fig. 6.
1848. — Henslowi, *J. G. Cumming*. Isle of Man, p. 127.
— — — *H. G. Bronn*. Gesch. d. Natur, vol. iii, p. 542.
— — spurius (pars), *H. G. Bronn*. Ibid., vol. iii, p. 545.
1850. Aganides Henslowi, *A. d'Orbigny*. Prod. de Paléont. stratigr., vol. i, p. 115.

[1] 'Geol. Surv. Ireland,' Explan. Sheet 142 of the Maps, 1860, pp. 11—13, figs. 2 *a*—*m*.

1850. Nautilus compressus, *A. d'Orbigny.* Prod. de Paléont. stratigr., vol. i, p. 110.
1852. Ammonites Henslowi, *C. G. Giebel.* Fauna der Vorwelt, vol. iii, p. 451.
— Nautilus compressus, *C. G. Giebel.* Ibid., p. 178.
1854. Goniatites compressus, *J. Morris.* Cat. Brit. Foss., 2nd ed., p. 303.
— Nautilus (Discites) compressus, *J. Morris.* Ibid., p. 308.
1855. Aganides Henslowi, *F. M'Coy.* Brit. Pal. Foss., p. 564.
1881. Goniatites Henslowi, *C. Barrois.* "El marmol amigdaloide de los Pirineos," Boletin de la Comision del Mapa geologico de España, vol. viii, 1881, p. 9, pl. c, figs. 3 *a*—*c*.
1882. Prolecanites Henslowi, *E. von Mojsisovics.* Abhandl. der Kais.-Kön. geol. Reichsanst., vol. x, p. 199.
1884. — — *K. A. von Zittel.* Handb. d. Palæont., vol. ii, p. 421.
— "*Ammonites Henslowi*, L. von Buch," *E. Beyrich.* Zeitschr. Deutsch. geol. Gesell., vol. xxxvi, p. 210.
1888. Goniatites Henslowi, *R. Etheridge.* Brit. Foss., vol. i, Palæozoic, p. 311.
— Discites compressus, *R. Etheridge.* Ibid., vol. i, Palæozoic, p. 310.
1889. Prolecanites Henslowi, *E. Holzapfel.* Palæont. Abhandl., Dames und Kayser, vol. v, i, p. 42, pl. iii, fig. 14; pl. iv, figs. 2, 4, 7.
1891. Discites compressus (pars), *A. H. Foord.* Cat. Foss. Ceph. British Museum, pt. 2, p. 91.
1892. Goniatites (Prolecanites) Henslowi, *J. Seunes.* Comptes Rendus, vol. cxv, p. 681.
1894. Prolecanites compressus, *A. H. Foord and G. C. Crick.* Geol. Mag. (4), vol. i, p. 11, pl. i.
1895. — — *G. C. Crick.* Trans. Manchester Geol. Soc., vol. xxiii, pt. 3, p. 83; woodcut, p. 86.
— — Henslowi, *K. A. von Zittel.* Grundzüge der Palæont., p. 400.
1897. — compressus, *A. H. Foord and G. C. Crick.* Cat. Foss. Ceph. Brit. Mus., pt. 2, p. 252, fig. 121.
1901. — — *Wheelton Hind and J. A. Howe.* Quart. Journ. Geol. Soc., vol. lvii, p. 349, etc.
1902. — — *Wheelton Hind.* Brit. Assoc. Adv. Sci., Glasgow, 1901, p. 296: "Life-zones in the Carboniferous Rocks."

Description.—"Shell discoidal, compressed, evolute, widely umbilicated; greatest thickness at about the middle of the lateral area, about one-fourth of the diameter of the shell. Whorls seven or eight; inclusion almost nil; umbilicus shallow, about two-fifths of the diameter of the shell in width. Whorl subtrapezoidal in section, higher than wide; scarcely indented by the preceding whorl; periphery flattened, feebly convex in the middle, but slightly concave near each margin, with prominent subangular margins; sides flattened, feebly convex, becoming more inflated on the body-chamber; inner area fairly well defined, slightly convex, sloping towards the

umbilicus. Body-chamber occupying at least half of a whorl. Chambers rather shallow, fourteen or fifteen in a whorl. . . . Test thin, nearly smooth, with obscure lines of growth, which form a shallow sinus on the lateral area, and a broad, shallow sinus on the periphery." ('Cat. Foss. Ceph.,' loc. cit.)

Affinities.—On comparing this species with *Prolecanites ceratitoides*, von Buch, it is found to have more rapidly increasing whorls, and it also differs from the latter in its suture-line, in which the peripheral lobe is infundibuliform instead of being expanded posteriorly as it is in von Buch's species. The present species is distinguished from *P. similis*, Crick,[1] (1) by its more rapidly increasing whorls, (2) by the presence of the conspicuous angular lobe on the inner area of the whorl.

Remarks.—Although a full account of the history of this species was given by Mr. G. C. Crick and myself in the 'Geological Magazine' for January, 1894 (see synonymy above), it will be useful to recapitulate at least the substance of it, which is as follows:—J. Sowerby described in the 'Mineral Conchology' (vol. i, 1813) a cephalopod which he named *Ellipsolites compressus* without expressing any definite opinion at the time as to its affinities. Most succeeding writers have classed it from its general form either with *Nautilus* or with *Discites*. In looking over Mr. Wright's collection of fossils at Belfast, I was struck by the marked external resemblance of certain specimens to Sowerby's *Ellipsolites compressus*, one of them showing very clearly the suture-line characteristic of *Prolecanites*. On comparing this with Sowerby's two type specimens in the British Museum, it was found that the smaller one of the latter showed unmistakable traces of the same sutural characters, thus establishing the connection between these and Mr. Wright's specimens, while indicating at the same time their generic position. The character of the septa in these forms naturally suggested a further comparison with such species as were known to possess a similar septation; among these the "*Ammonites Henslowi*" of J. Sowerby was carefully examined, and proved to be identical with "*Ellipsolites compressus*;" thus both these names became synonyms of *Prolecanites compressus*, the specific name "*compressus*" being adopted in virtue of its priority over "*Henslowi*," which was employed by Sowerby seven years later. It is interesting to note that the specimens to which J. Sowerby gave the name *Ammonites Henslowi* came from the well-known Carboniferous deposits at Scarlet in the Isle of Man, where casts of the species appear to be tolerably abundant. As it has been recognised also from the Carboniferous Limestone of Asturias in Spain,[2] its geographical range is fairly extensive.

The specimen numbered "6" on Pl. XLVII claims attention on account of its being almost completely undistorted. This I consider to be the individual specimen

[1] 'Trans. Manchester Geol. Soc.,' vol. xxiii, 1895, pt. 3, p. 80; woodcut, p. 87. Also 'Cat. Foss. Ceph. British Museum,' part 3, 1897, p. 259, fig. 124 (suture-line).

[2] 'Cat. Foss. Ceph. Brit. Mus.,' 1897, pt. 3, p. 254.

named "*Goniatites discus*" by M'Coy, and figured in the "Synopsis," pl. ii, fig. 6, in which, like some other figures in the plates of that work, it has been reversed by the lithographer, who has also left out the rock in which it is partly embedded. In the figure of the suture-line given by M'Coy (loc. cit.) it is represented as having a divided first lateral lobe, but a careful examination of the specimen shows that such is not the case, but that the first lateral lobe terminates in a single point; and further, that the peripheral lobe is not V-shaped, as M'Coy represents it to be, but is shaped somewhat like the lateral lobes, being slightly contracted above, expanded below, and terminating in a rather acute point.[1]

I may here supply an omission in the diagnosis of the species, and that is that in the adult shell a very conspicuous rim or keel is present at the angles of the periphery on each side. I would further mention the occurrence of "epidermids," seen on the concave impressed zone of the antiperipheral area of the large specimen figured on Pl. XLVIII, fig. 4*a* (here reduced to about one-half of the natural size), on a part of the body-chamber which, owing to a fracture, can be detached from the specimen. These epidermids consist of short, rather coarse, interrupted, transverse, impressed, wavy lines, which become finer and more pit-like at the ridges bounding the area referred to. The condition of the fossil is such that they cannot be definitely made out on the sides of the body-chamber; but on the periphery, near its subangular margin, their punctate character can be distinctly seen.

The features of this interesting species are, I think, well displayed upon the plate, and my only regret is that, owing to want of space, I was obliged to represent fig. 4 *a* one-half its natural size. Fig. 7 is the suture-line of a specimen from the Isle of Man, and is intended to show the peripheral lobe which is not preserved in the Cork specimen (4*c*). The figures of the suture-lines are drawn full size.

The largest specimen known to me is a fragment which I obtained at Little Island, near Cork; it is now in the Museum of Science and Art, Dublin; it has become elliptical by pressure, the longest diameter measuring about 200 mm.; other measurements would be scarcely trustworthy owing to the great distortion of this specimen. A somewhat smaller individual from the same locality, with more nearly normal proportions, has a height of body-whorl of 56 mm. at a position probably not far from the aperture.

Localities.—Cork (city); Little Island, Blackrock, and Midleton, near the city of Cork; Ballynabointra, county of Cork (East Riding); "Four miles east of Loughrea," county of Galway.

[1] 'Geol. Mag.,' dec. 4, vol. i, Jan., 1894, p. 11: "On the Identity of *Ellipsolites compressus*, J. Sowerby, with *Ammonites Henslowi*, J. Sowerby;" by A. H. Foord and G. C. Crick.

APPENDIX.

CONTENTS.

	PAGE
Temnocheilus coronatus	206
Solenocheilus clausus (with remarks on *Solenocheilus*)	207
Brancoceras Enniskillenense	208
Glyphioceras, sp.	209
Glyphioceras, sp.	209
Glyphioceras, sp.	210
Synopsis of Families, Genera, and Species	210
Concluding Remarks, etc.—	
I. Palæontology	220
II. Geology	224
Divisions of the Carboniferous System of Ireland	225
Alphabetical List of Localities and Horizons	225
Errata	227
Index of Families, Genera, Species, etc., contained in the Monograph	229

Genus Temnocheilus (see *ante*, p. 49).

Temnocheilus coronatus, *F. M'Coy*. Plate XLIX, figs. 15 *a*, *b*. (Also *ante*, p. 49, Plate XVIII, figs. 1, 2.)

By great good luck a fine specimen of this species has been found in the quarries of Little Island, near Cork, where the original specimen was obtained more than half a century ago. The present specimen[1] is much larger than the type, and, unlike the latter, it is only very slightly distorted, as a glance at the figure shows.

The inner whorls, hidden by the matrix in the M'Coy specimen, are completely exposed in the new one. The sutures are seen here and there both in the inner

[1] This has been very skilfully separated from the rock by its present possessor, Mr. James Duffy, of Dublin, to whom the author is indebted for the loan of it. Mr. Duffy's success in the frequently difficult and delicate operation of freeing fossils from a refractory matrix without injuring them, added to his keen eye for rarities, has already contributed much to the enrichment of the palæontological collections in Dublin and elsewhere.

and outer whorls; they are 6 mm. apart where the sides of the shell have a breadth of 16 mm., and 8 mm. apart where the latter has increased to 21 mm. The principal dimensions of the shell are as follows:—Diameter 115 mm., height of outer whorl near the aperture 35 mm., breadth of peripheral area at the same place 55 mm., breadth of umbilicus 57 mm., diameter of its central vacuity 11 mm. The test bears no trace of ornamentation except in the first whorl, where fine and rather distant longitudinal ridges are developed.

Genus Solenocheilus (see *ante*, p. 126).

Solenocheilus clausus (see *ante*, p. 130).

When describing this species only one specimen was available, and as the siphuncle was not to be seen in it I felt doubtful as to its belonging to *Solenocheilus*. This doubt is removed by the information supplied by a small specimen that lately passed through my hands in which the position of the siphuncle is characteristically peripheral. This specimen is from the same locality, Little Island, near Cork, as the original one. A large crushed and distorted specimen from this locality in Mr. James Duffy's collection measures 223 mm. in the longer diameter of the ellipse into which it has been drawn out. It has a deep and wide hyponomic sinus in the aperture.

Remarks.—During the preparation of this part of the present Monograph I have been favoured by Dr. E. von Mojsisovics with a copy of the supplementary part of his valuable memoir on the Cephalopoda of the Hallstätter Kalke (in 'Das Gebirge um Hallstat,' Abtheilung 1, Band i, Supplement Heft, Wien, 1902). The opportunity is thus afforded me of referring to it in connection with the genus forming the subject of this addendum.

In the "Phylogeny of an Acquired Characteristic" (extr. from 'Proc. Amer. Phil. Soc.,' vol. xxxii, No. 143, Aug. 20, 1894) Professor Hyatt established the genus *Syringoceras* for the group of *Nautilus Barrandei*, E. v. Mojs., to include "Triassic species like the type, *Syringoceras granulosostriatus*, which have a tubular, nepionic volution with the siphuncle subventran [marginal as to the periphery]. The early nepionic [immediately post-embryonic] shell is also ornamented with very closely set transverse ridges, but it has no longitudinal ridges until a comparatively late stage. This nepionic ornamentation is like that of the genus *Hercoceras* at the same age. The impressed zone is present only after contact, and is not deep."

Dr. von Mojsisovics accepts this genus (p. 214 of his work above quoted), but includes in his synonymy of it "Solenocheilus (Meek and Worthen), Foord" ('Cat. Foss. Ceph. Brit. Mus.,' pt. 2, p. 165), without any reference to Hyatt's amended diagnosis of *Solenocheilus* in the 'Geological Survey of Texas' ("Carboniferous Cepha-

lopods;" Fourth Annual Report, 1892, p. 460), which I append here for comparison with that of *Syringoceras*:—"The whorl increases very rapidly by growth, and the living chambers are short, with flaring apertures. The venter [peripheral area] is elevated and gibbous, the lateral zones more or less gibbous, and the umbilical shoulders tend to project in heavy ridges extending to and modifying the form of the aperture. The dorsum in the young often till a late stage may have no impressed zone. The sutures have broad, shallow ventral lobes, corresponding saddles at the umbilical shoulders, and lobes on the dorsum with small annular lobes. The siphuncle is ventral."

I think there are few palæontologists who would not, as I do, regard the differences between *Solenocheilus* and *Syringoceras* as of sufficient importance to justify their separation, the only essential character in which they are in agreement being the peripheral situation of the siphuncle.

That Professor Hyatt had no idea of suppressing *Solenocheilus* in favour of *Syringoceras* is shown by his having again introduced it in Eastman's translation of Dr. von Zittel's 'Text-book of Palæontology' (p. 525), where he allots it a position in the family Solenocheilidæ, along with other allied genera. *Syringoceras* he places in his family Grypoceratidæ, which embraces the two Triassic genera *Syringoceras* and *Grypoceras*.

Dr. von Mojsisovics closes his generic description of *Syringoceras* by stating that it ranges from the Muschelkalk to the Carinthian stage (beds with *Trachyceras Aonoides*), but it is obvious that if *Solenocheilus* were merged in *Syringoceras* the range of the latter would extend not from the Muschelkalk only, but from the Carboniferous.

Looking at the matter from another point of view; even if a fusion of the two genera were justifiable, *Solenocheilus* having the priority would have to be retained at the expense of *Syringoceras*.

Genus Brancoceras (see *ante*, p. 131).

Brancoceras Enniskillenense, sp. nov. Plate XLVII, figs. 3 *a*, *b*.

Description.—Shell (? young) discoidal, compressed, umbilicated; greatest thickness at the umbilical margin; height of outer whorl about three-tenths of the diameter of the shell. Whorls (? number); inclusion nearly complete; umbilicus deep, rather wide, with angular margin and very steep sides. Whorl oval in section, apparently a little higher than wide. Periphery broadly rounded in the very young shell (Pl. XLVIII, figs. 3 *a*, *b*), subangular, with a slight keel, at a more advanced stage of growth (Pl. XLVII, fig. 3 *a*). Sides somewhat flattened around the umbilicus, more rounded in the peripheral region. Extent of the body-chamber unknown. Chambers, known only in the very young shell, rather wide

apart, but the peripheral (external) lobe is of such a length that the apex is invaginated in the opening of the preceding lobe, thus bringing the septa into close connection at this point. Test ornamented in all stages of growth with very delicate, apparently imbricating, transverse striæ, which are perfectly distinct, and are therefore an important specific feature. After leaving the border of the umbilicus they form a broad forwardly directed curve, and then bending backwards make rather a deep hyponomic sinus upon the periphery. Very faint and distinct lines of growth appear upon the cast of the body-chamber. The narrow periphery is produced into a slight keel. Shallow and slightly undulating constrictions appear on the young shell.

Affinities.—This species is readily distinguished from other Carboniferous species of *Brancoceras* by its form and ornamentation. In the former the most remarkable feature is the angularity of the periphery.

Remarks.—This species was labelled "Goniatites excavatus" on the tablet to which it was affixed, and I at first accepted this interpretation of its affinities, but in looking more closely at it I found that the sutures were clearly and sharply defined upon the hollow mould left by the removal of the innermost whorls in extracting the fossil from the rock. An inspection of them left no doubt as to their being those of *Brancoceras*, and according to this view I have allocated the specimen, with a specific name derived from the locality in which it was found.

Locality.—Black Lion, near Enniskillen, county of Leitrim.

GLYPHIOCERAS ? sp. Plate XLIII, figs. 4 *a*, *b*.

The specimen here figured in two aspects is a cast without any trace of the test remaining upon it. I had at first assigned it to *G. mutabile*, J. Phillips, but its immature condition and the absence of any characters which could connect it definitely with that species induces me after all to leave it unnamed as the wiser course.

Locality.—Cregg, near Nobber, county of Meath.

GLYPHIOCERAS ? sp. Plate XLVIII, figs. 2, *a*, *b*.

This is the cast of the body-chamber of a small shell, which is partly embedded in the matrix. The shell is compressed, with a narrowly rounded periphery and rather flattened sides. The umbilicus is wide and deep, with steep sides having angular margins. The inclusion leaves very little of the inner whorls exposed. The ornamentation consists of very delicate imbricating transverse striæ. The diameter of the shell is about 26 mm., while that of the umbilicus is 11 mm., thus about two-fifths. As the suture-line is not seen the generic position of this shell is doubtful.

Locality.—Black Lion, near Enniskillen, county of Leitrim.

Glyphioceras ? sp. Plate XLVIII, figs. 3 *a*, *b*.

This small fragment of a rather widely umbilicated shell, the inner whorls of which are minutely and regularly striated transversely, is very difficult to determine specifically. It bears some resemblance to *G. stenolobum*, J. Phillips, but the umbilicus is proportionally larger, and it is a more inflated shell than the latter. As I cannot recognise in it the young of any species known to me I have not ventured to name it.

Synopsis of Families, Genera, and Species contained in this Monograph, with descriptions of the Families and Genera; the new species marked with an asterisk.

Sub-order—NAUTILOIDEA.

Family—Orthoceratidæ, *M'Coy*, 1844.

Longicones and Brevicones, with cylindrical siphuncles and widely separated septa. Body-chamber large; aperture with an entire peristome.

Genus Orthoceras (*Breyn*, 1732).—Shell straight or slightly curved; elongate-conical; circular or subelliptical in cross-section. Septa concave, usually horizontal, sometimes slightly oblique. Siphuncle of variable dimensions; cylindrical; central or excentric; calcareous deposits sometimes present. Septal necks short or reaching to the next septum. Body-chamber large; aperture entire, scarcely ever contracted; sometimes with a constriction below it. Surface of test frequently with transverse or longitudinal ornaments (annulations, ribs, striæ, etc.).

Cambrian to Trias.

A. Longicones.

I. *Group* Lævia. (*Species with smooth test.*)

Sub-group Cylindriformes. (*Species with cylindrical siphuncle.*)

1. Orthoceras Leinsterense.*
2. ,, variabile.*
3. ,, Colei.*
4. ,, Nolani.*
5. ,, Sancti-Doulaghi.*
6. ,, acre.*
7. Orthoceras cylindraceum.
8. ,, Nerviense.
9. ,, amabile (?).
10. ,, calamus.
11. ,, Porteri.*
12. ,, venabulum.*
13. Orthoceras perapproximatum.*

Sub-group Moniliformes. (*Species with moniliform siphuncle.*)

14. Orthoceras Hindei.* 15. Orthoceras subclavatum.* 16. Orthoceras pilum.*

II. *Group* Annulata. (*Species with transverse annulations.*)

17. Orthoceras lævigatum.

III. *Group* Angulata. (*Species with longitudinal ridges.*)

18. Orthoceras Wrightii.

IV. *Group* Lineata. (*Species with fine transverse or longitudinal lines.*)

19. Orthoceras Kildarense.* 21. Orthoceras Hibernicum.*
20. ,, salvum. 22. ,, pulcherrimum.*

V. *Group* Imbricata. (*Species with imbricating striæ.*)

23. Orthoceras Clanense.* 25. Orthoceras multistriatum.*
24. ,, Sollasi.* 26. ,, perellipticum.*

B. Brevicones.

27. Orthoceras perconicum.*

Family—Actinoceratidæ, Saemann, 1854.

Longicones and Brevicones with large nummuloidal siphuncle, and endosiphuncle; the latter usually with calcareous deposits, and connected by tubuli with the wall of the siphuncle.

Genus Actinoceras (*Broun*, 1837). -Shell straight, elongate-conical; cross-section circular to subcircular. Septa usually more arcuate than in *Orthoceras;* necks (funnels) very short. Siphuncle very large, the diameter sometimes amounting to half that of the shell; much inflated between the septa, forming a series of segments of a compressed-globular shape, with calcareous wall; often contracted by crystalline deposits secreted about the necks ("anneaux obstructeurs" of Barrande). Between these deposits runs longitudinally the endosiphuncle (prosipho), which has a distinct wall and gives off at intervals a number of radiating canals or tubuli which reach and penetrate the wall of the siphuncle. The siphuncle forms, as in *Endoceras*, the

conical initial chamber of the shell, but is perforated just above the apex by a large foramen.

Cambrian to Carboniferous.

28. Actinoceras giganteum. 29. Actinoceras insulare.* 30. Actinoceras propinquum.*

Family—Cyrtoceratidæ, Chapman, 1857.

Longicones and Brevicones with curved shell and short, often compressed body-chamber. Siphuncle nummuloidal, usually filled with radiating deposits. Aperture with an entire peristome.

Genus Cyrtoceras (Goldfuss, 1832).—Shell curved, tapering rapidly (brevicones), or more slowly (longicones); cross-section elliptical, ovate, or circular. Siphuncle moderately large, nummuloidal, generally situated near the convex (ventral) curvature of the shell, usually with well-developed radiating deposits or obstruction-rings. Body-chamber short; aperture simple. Septa greatly elevated towards the ventral side owing to the curvature of the shell.

Cambrian to Permian.

Sub-genus Meloceras (Hyatt, 1883).—Shell compressed, generally with a marked curvature only in the apical region. Section broadly ovate to elliptical. Siphuncle nummuloidal, external (exogastric), internal (endogastric), or, more rarely, subcentral (mediogastric). Body-chamber usually short, with a tendency to contraction towards the aperture in some species.

31. Cyrtoceras (Meloceras) apicale.* 32. Cyrtoceras (Meloceras) arcuatoseptatum.*

Genus Eusthenoceras (*Foord*, 1898).—Shell large, typically curved only in the apical portion. Septa at first approximate, afterwards becoming very widely separated. Sutures arching upwards on the dorsal or inner curvature of the shell. Siphuncle subcentral in the direction of the ventral region, apparently cylindrical.

Carboniferous.

33. Eusthenoceras Hulli. 34. Eusthenoceras Bailyi.

Family—Poteriocerатidæ, *Foord*, 1888.

Fusiform, slightly curved shells, inflated in the middle, with slender apex. Sutures often oblique to longitudinal axis; siphuncle moniliform, with an endosiphuncle in adult stage. Aperture with the peristome entire.

Genus Poterioceras (*M'Coy*, 1844).—Shell fusiform, the curvature slight, very slender in the apical portion, inflated in the middle, contracting towards the aperture, which is simple. Cross-section nearly circular in the young, elliptical in the adult. Siphuncle subcentral to marginal, moniliform. Body-chamber proportionately large, constricted near the aperture. Test smooth.

Ordovician to Carboniferous.

35. Poterioceras fusiforme. 36. Poterioceras latiseptatum.*

37. Poterioceras ventricosum.

Family—Tainoceratidæ, *Hyatt*, 1883 (emend. 1893, 1900).

Discoidal, whorls usually robust, trapezoidal in section at some stage of growth, or throughout life, tuberculated; sutures without annular lobe; siphuncle small and cylindrical.

Genus Temnocheilus (*M'Coy*, 1844).—Shell subdiscoidal, umbilicus generally large and deep. Periphery broad and flattened. Whorls usually but little embracing; cross-section trapezoidal at all stages of growth. One row of nodes on each side of the periphero-lateral margin.

Carboniferous.

38. Temnocheilus coronatus.

Family—Trigonoceratidæ, *Hyatt*, 1883 (emend. 1893, 1900).

Whorls subtriangular at some stage of growth or throughout life, often with longitudinal ridges; body-chamber sometimes free near the aperture. Annular lobe rarely present. Siphuncle small, submarginal.

Genus Trigonoceras (M'Coy, 1844).—Shell rapidly tapering, the apical part forming half a volution (*fide* M'Coy), the rest gently curving. Cross-section scutiform. Peripheral area distinctly concave; anti-peripheral edge carinated. Siphuncle subcentral in the direction of the peripheral area. Obtuse longitudinal ridges occur at the peripheral angles.

Carboniferous.

39. Trigonoceras paradoxicum.

Genus Cœlonautilus (*Foord*, 1891, emend. *Hyatt*, 1893).—Shell compressed-discoid, deeply umbilicated. Cross-section subtriangular. Peripheral area very broad,

often with more or less prominent ridges. Siphuncle subcentral in the direction of the periphery to nearly marginal.

Carboniferous.

Group of Cœlonautilus planotergatus.

40. Cœlonautilus planotergatus. 41. Cœlonautilus Doohylensis.*
42. Cœlonautilus gradus.*

Genus Stroboceras (*Hyatt*, 1883, emend. 1893).—Shell compressed-discoid, with elevated peripheral area and prominent ridges separated by furrows on the sides.

Carboniferous.

Group of Stroboceras sulcatum.

43. Stroboceras sulcatum. 44. Stroboceras crassum.*

Genus Apheleceras (*Hyatt*, 1883, emend. 1893).—Shell compressed-discoid. Cross-section subhexagonal. Peripheral area very narrow, sulcated more or less deeply. Umbilical vacuity large; the first whorl generally completed before the succeeding one touches it. Young shell with lateral and ventral longitudinal ridges.

Carboniferous.

Group of Apheleceras mutabile.

45. Apheleceras mutabile. 46. Apheleceras Hibernicum. 47. Apheleceras trochlea.

Genus Mesochasmoceras (*Foord*, 1900).—Shell discoidal, much compressed. Whorls slowly tapering, narrow, with a very large umbilical vacuity. Cross-section subhexagonal. Periphery slightly channelled. No ornamentation at any stage of growth.

Carboniferous.

48. Mesochasmoceras latidorsatum.

Genus Diorugoceras (*Hyatt*, 1893). —Shell with more compressed whorls than those of *Apheleceras*. Periphery channelled. Involution almost complete in the adult. (This genus is represented by only one species, and is not satisfactorily defined.)

Carboniferous.

49. Diorugoceras planidorsatum.

Family—Tribolocerati.e, *Hyatt*, 1883 (emend. 1893, 1900).

Whorls similar to those of Trigonoceratidæ; periphery may be concave or convex; annular lobe in all genera except *Coloceras*.

Genus Triboloceras (Hyatt, 1883, emend. 1893).—Shell discoid. Cross-section subhexagonal. Periphery with a broad, elevated, median zone in the adult. Prominent ridges on the sides and periphery, which are often rendered subspinous by the coarse transverse lines of growth.

Carboniferous.

50. Triboloceras formosum.*

Genus Vestinautilus (*Rychholt*, 1852, emend. *Hyatt*, 1883, 1893).—Shell thick-discoid. Cross-section subhexagonal. Apparently smooth and rounded in the very young stage of growth. Periphery broadly rounded, with more or less distinct ridges both on the sides and periphery, tending to become obsolete in the adult or senile stage. Thick nodes are sometimes present upon the latero-peripheral angles of the body-chamber in adult shells.

Carboniferous.

51. Vestinautilus semiglaber.*
52. ,, crassimarginatus.*
53. ,, cariniferus.
54. ,, ,, var. magnicameratus.*
55. ,, ,, var. triplicatus.*
56. Vestinautilus crateriformis.*
57. ,, paucicarinatus.
58. ,, pinguis.
59. ,, semiplicatus.*
60. ,, multicarinatus.

Genus Planetoceras (*Hyatt*, 1893).—Shell subglobose. Cross-section pentagonal in the adult, thus differing from *Triboloceras* and *Vestinautilus*. Body-chamber partly free from the rest of the shell; greatly depressed and laterally expanded.

Carboniferous.

61. Planetoceras globatum.

Genus Coloceras (*Hyatt*, 1893).—Shell thick-discoid, section subquadrangular. Periphery with numerous ridges in the early stages of growth and two elevated zones on each side of a median depression.

Carboniferous.

62. Coloceras Coyanum.
63. Coloceras bistriale.

Family—Rhinoceratidæ, *Hyatt*, 1893 (emend. 1900).

Whorls stout, tetragonal in section, with convex periphery; longitudinal ridges are developed; annular lobe present in most genera.

Genus Thrincoceras (*Hyatt*, 1893).—Shell thick-discoid, typically large. Cross-section subhexagonal. Periphery broad and depressed. Test covered with close-set spiral ridges.

Carboniferous.

64. Thrincoceras Hyatti.*
65. Thrincoceras Hibernicum.

Genus Discitoceras (*Hyatt*, 1883, emend. 1893).—Shell compressed-discoid. Sides and periphery flattened. Outline of aperture distinctly sigmoid. Longitudinal ridges present in the young shell.

Carboniferous.

66. Discitoceras Leveilleanum.
67. „ Wrightii.*
68. Discitoceras costellatum.
69. „ ? discors.

Genus Phacoceras (*Hyatt*, 1883, emend. 1893).—Shell typically discoid, much compressed. Cross-section narrowly sagittate. Periphery acutely angular. Young having apparently the form and proportions of *Discitoceras* at that stage.

Carboniferous.

70. Phacoceras oxystomum.
71. Phacoceras ? rectisuturale.*

Family—Solenocheilidæ, *Hyatt*, 1893 (emend. 1900).

Whorls may be open or closed; depressed elliptical or broadly hemispherical in outline; umbilical zone very broad; shell smooth; some species have spinose, others wing-like projections at the margin of the aperture proceeding from the umbilical rim.

Genus Aipoceras (*Hyatt*, 1883, emend. 1893).—Shell rapidly increasing, with an open coil. Cross-section subtriangular. Whorls compressed at the sides, flattened on the dorsal aspect. Test smooth.

Carboniferous.

72. Aipoceras compressum.
73. Aipoceras ? Hainesianum.*

Genus Acanthonautilus (*Foord*, 1896).—Shell *Nautilus*-like, subglobose, with somewhat flattened peripheral area. Umbilicus rather large, funnel-shaped, with a

thickened rim which is produced on each side into a long, flat, spine-like process projecting nearly at right angles to the longitudinal axis of the shell.

Carboniferous.

74. Acanthonautilus bispinosus.

Genus Asymptoceras (*Ryckholt*, 1852, emend. *Hyatt*, 1893).—Shell *Nautilus*-like, with subquadrate whorls. Body-chamber contracted in some species; the aperture may have the inferior border thickened into a prominent lip, or there may be a distinct inflation just below this border. Siphuncle at the margin of the periphery just beneath the test.

Carboniferous.

75. Asymptoceras crassilabrum.* 76. Asymptoceras Foordi.

Genus Solenocheilus (*Meek and Worthen*, 1870, emend. *Hyatt*, 1883, 1893).—Shell *Nautilus*-like, subglobose. Cross-section broadly sagittate. Periphery elevated and rather narrowly rounded, the umbilical angles of the aperture projecting on each side. Siphuncle marginal as in *Asymptoceras*.

Carboniferous.

77. Solenocheilus dorsalis. 78. Solenocheilus ? Hibernicus.

79. Solenocheilus clausus.*

Sub-order AMMONOIDEA.

Family—Glyphioceratidæ, *Hyatt*, 1883 (emend. J. Perrin Smith, 1897; Hyatt, 1900).

[Sub-order *Eurycampyli*, Hyatt, 1900 (pars), in Eastman's transl. of von Zittel's 'Grundz. d. Palæont.']

Shells of variable form, including highly involute ones and also some with open umbilicus exposing all the inner whorls. Septa concave along the median line of the periphery in *Brancoceras*, the primitive form, convex in the mature stages of other genera; peripheral lobe entire in primitive forms, but becoming divided in more specialised genera; lateral saddle simple or, very rarely, divided by a second lateral lobe. Siphuncle small; septal necks short, usually with a forwardly-directed collar.

Genus Brancoceras (*Hyatt*, 1883).—Shell involute, discoidal and compressed; umbilicus narrow or closed; surface of test smooth or with fine transverse ribbing;

suture-line—peripheral lobe[1] deep and undivided, peripheral saddles[2] rounded; lateral lobes narrow and deep, lateral saddles broadly rounded.

Upper Devonian and Carboniferous.

80. Brancoceras ornatissimum. 81. Brancoceras Enniskillenense.*

Genus Pericyclus (*Mojsisovics*, 1882, emend. *Hyatt*, 1883).—Shell involute, subglobose to compressed, narrowly to widely umbilicated; surface of test with strong, direct, transverse ribs, forming a shallow sinus on the periphery, but usually without any sinuosity on the sides of the shell; constrictions present in some species; suture-line—peripheral lobe divided by a small median saddle;[3] peripheral saddles broadly rounded or spatulate; lateral lobes pointed, deep; lateral saddles broadly rounded, or forming a shallow arch; usually with a small auxiliary lobe at the umbilicus.

Carboniferous.

82. Pericyclus funatus.
83. „ fasciculatus.
84. „ Doohylensis.
85. „ multicostatus.*
86. „ Foordi.
87. „ subplicatilis.
88. Pericyclus trapezoidalis.
89. „ Bailyi.
90. „ rotuliformis.
91. „ plicatilis.
92. „ Clanensis.
93. „ Leesoni.

Genus Glyphioceras (*Hyatt*, 1883, emend. J. Perrin Smith, 1897).—Shell involute, globose to compressed; umbilicus usually narrow or closed; periphery strongly convex to subacute; surface of test smooth or finely striated, often with periodic constrictions; suture-line—peripheral lobe divided by a small median saddle; peripheral saddles narrow, rounded or pointed; lateral lobes acute or subacute, deep; lateral saddles broadly rounded or obtusely angular; usually with a small auxiliary lobe at the margin of the umbilicus.

Carboniferous and Permo-Carboniferous.

Sub-genus Sphenoceras,[4] sub-gen. nov. (= *Glyphioceras*, Section I [pars], of Hyatt).—Shell involute, globose, with narrow or closed umbilicus, the whorl semilunate in section; surface of test longitudinally or spirally striated, with periodic constrictions; suture-line—peripheral lobe with a prominent median saddle dividing it into two acute terminations; peripheral saddles inclined towards the umbilicus, often acute; lateral lobes acute or very narrowly rounded; lateral saddles broadly rounded, sometimes with a subacute apex.

94. Sphenoceras sphæricum. 95. Sphenoceras crenistria. 96. Sphenoceras striatum.

[1] Known also by the names "outer," "external," and "ventral" lobe.

[2] Known also as the "lateral" saddle or "first lateral" saddle.

[3] Called also the "siphonal" saddle.

[4] Referring to the wedge-shaped peripheral saddles and lateral lobes.

Sub-genus Beyrichoceras, sub-gen. nov. (= *Glyphioceras*, Section II [pars], of Hyatt).—Shell involute, usually compressed, with rounded, sometimes depressed periphery, umbilicus variable, generally small. Surface of test usually smooth or only marked with lines of growth, rarely with transverse ribbing or with spiral striæ. Suture-line resembling that of *Sphenoceras*, but with the peripheral saddles rounded or linguiform, never acutely pointed; peripheral lobe usually shallow, median saddle small and larval in shape; lateral lobes acutely to obtusely pointed, sometimes mucronate; lateral saddles broadly rounded, when less so the apex points towards the peripheral saddle on each side.

97. Beyrichoceras obtusum.
98. ,, truncatum.
99. ,, subtruncatum.*
100. ,, occidentale.*
101. ,, difficile.*
102. ,, subquadratum.*
103. ,, sphæroidale.
104. ,, Browni.
105. ,, corpulentum.
106. Beyrichoceras micronotum.
107. ,, diadema.
108. ,, reticulatum.
109. ,, subreticulatum.*
110. ,, bilingue.
111. ,, Davisi.
112. ,, cordatum.
113. ,, pulchellum.*
114. ,, spirale.

Sub-genus Muensteroceras (Hyatt, 1883).—Shell globose to subglobose and compressed; umbilicus of variable dimensions; whorls higher than wide; surface of test with more or less regular lines of growth, or with reticulate lines. Suture-line—peripheral lobe deep, often with subparallel sides; the median saddle small as in *Beyrichoceras;* peripheral saddles rounded or spatulate; lateral lobes acutely to obtusely pointed; lateral saddles broadly rounded, or forming a wide-spreading shallow arch.

115. Muensteroceras crassum.* 116. Muensteroceras ellipsoidale.
117. Muensteroceras obesum.*

Genus Gastrioceras (Hyatt, 1883, emend. Karpinsky, 1889).—Shell globose or subcompressed, with trapezoidal cross-section, usually widely umbilicated, whorls numerous, periphery broadly rounded. Surface of test with longitudinal striæ, or with transverse ribs, the umbilical margin usually bearing tubercles or tubercular ribs; constrictions often present; suture-line—peripheral lobe broad and sometimes with mucronate terminations (*G. Iassæ*, e. g.), divided by a broad and elevated median saddle; peripheral saddles broadly rounded, or spatulate; first lateral lobes deep, linguiform, with mucronate extremities in some species; second lateral lobes small, angular, situated upon the umbilical margin, or upon the inner (umbilical) area; lateral saddles sometimes broadly, sometimes narrowly rounded or spatulate.

Carboniferous and Permo-Carboniferous.

118. Gastrioceras circumnodosum.* 119. Gastrioceras circumplicatile.*

Family—Prolecanitidæ, *Hyatt*, 1883 (emend. Karpinsky, 1890; Hyatt, 1900).

[Sub-order *Phyllocampyli*, Hyatt, 1900 (pars), in Eastman's transl. of von Zittel's 'Grundz. d. Palæont.']

Discoidal or involute, compressed, subquadrate, or helmet-shaped in section. Primitive forms with undivided peripheral lobe; more specialised forms with hastate lobes and saddles and divided peripheral lobe.

Genus Prolecanites (*Mojsisovics*, 1882; emend. Hyatt, 1883, 1900).—Shell discoidal, compressed, evolute, widely umbilicated, with a narrow, sometimes flattened periphery. Surface of test smooth or striated. Suture-line—saddles entire, narrowly rounded, constricted near the base, giving them a hastate appearance; lobes obtusely pointed; peripheral lobe undivided; two or three lateral lobes; auxiliary lobes absent or few in number; inner (antiperipheral) lobe narrow, deep, pointed, with a flat, broad, rounded lobe on each side of it.

Devonian and Carboniferous.

120. Prolecanites compressus.

CONCLUDING REMARKS.

I. Palæontology.

In C. R. Eastman's translation of von Zittel's 'Grundzüge der Palæontologie' (1900) a new scheme of classification of the Cephalopoda is introduced, the work of the late Professor Hyatt, which, though partly embodying the older scheme of the well-known 'Genera of Fossil Cephalopods' (1883), contains important modifications, involving the erection of many new sub-orders, groups, families, and genera. The scheme is complicated and somewhat defective as it stands; type species of the new genera are often omitted, while in other cases though the type species is named there is no description of the genus. An enumeration of typical forms would have greatly lessened this defect. We are told, however, in a note by the translator that "the classification and diagnoses are condensed from an exhaustive monograph on fossil Cephalopods, at present still in MS., which embodies the results of his [Hyatt's] life-study." The deficiencies referred to may

therefore be found to be remedied to a large extent in the complete work, the publication of which, owing to the lamented death of its accomplished author, has naturally lapsed, we trust only for a time.

As the greater part of the present Monograph had appeared before Eastman's 'Translation' was published, I was unable to make use of Hyatt's revised classification contained in it, which is here briefly outlined. As in the 'Genera of Fossil Cephalopods,' the structure of the siphuncle constitutes the leading feature of the larger divisions (sub-orders) of the Nautiloidea. Those forms having long septal necks or "funnels" which completely close the spaces between the septa, Holochoanites, include *Endoceras*, *Piloceras*, and other genera. Under the sub-order Mixochoanites, *Choanoceras*, *Ascoceras*, *Mesoceras*, etc., are placed. *Conoceras*, with some other aberrant genera, is put into the sub-order Schistochoanites. Orthochoanites includes a great number of genera, of which only a few can be named: *Orthoceras*, *Lituites*, *Clydonautilus*, *Vestinautilus*, *Hercoceras*, *Solenocheilus*, *Acanthonautilus*, *Nautilus*, and many others. Under Cyrtochoanites (in which the shortness of the septal necks is the leading feature), *Loxoceras*, *Actinoceras*, *Ooceras*, *Poterioceras*, *Gomphoceras*, *Phragmoceras*, and other genera are comprised.

In the Ammonoidea we are here concerned only with the primitive group of the Goniatites; these are arranged by Hyatt, together with the Ammonites, under new sub-orders, as follows:—*Gastrocampyli*[1] (= *Clymenia* of former systems), *Microcampyli*, *Mesocampyli*, *Eurycampyli*, *Glossocampyli* (= Goniatites [excepting Prolecanitidæ] of former systems), *Discocampyli* (= Ceratites of former systems), *Phyllocampyli* (including Prolecanitidæ, Noritidæ [Waagen], Medlicottidæ), *Leptocampyli*, *Pachycampyli* (= Ammonites of former systems).

Gastrocampyli is the equivalent of von Zittel's *Intrasiphonata;* the rest of the sub-orders are naturally included in his *Extrasiphonata*.

The method of arrangement of the species described in this Monograph may now be explained. The subdivisions of the Orthoceratidæ proposed by Hyatt in his provisional classification contained in the 'Genera of Fossil Cephalopods,' and founded mainly upon the external features of the shell, its ornamentation, shape, etc., met with only partial acceptance, owing to the difficulty of strictly limiting the genera, especially when forms of a transitional character had to be dealt with. It was therefore not adopted in this Monograph, in which the Orthoceratidæ are primarily divided into *Longicones* and *Brevicones*,[2] the former being again divided into groups and sub-groups according to the ornamentation of the test and the structure of the siphuncle. In this group the septation appears to be the least useful of the characters to be employed to differentiate its various elements, the

[1] "The suffix *campylus*, signifying curve, in the names of the sub-orders, is used wholly with reference to the saddle inflections as they appear in the typical forms of each group."

[2] Barrande, 'Syst. Sil. de la Bohême,' vol. ii, Texte, 1ère Partie, Rech. Pal., 1867, p. 8.

simplicity of form in these cylindrical shells being accompanied by a correspondingly simple form in the septa. It is noticeable that Hyatt makes no direct reference to the septation in defining his sub-orders, families, and genera of the Nautiloidea in Eastman's 'Translation,' but depends rather upon the nature of the septal necks and the siphuncle and its contents, if any, taking into account likewise characteristic ornamentation.

The arrangement of the remaining groups of the Nautiloidea (exclusive of the Actinoceratidæ, Cyrtoceratidæ, and Poterioceratidæ) follows in the main that of Hyatt's "Carboniferous Cephalopods," contributed to the 'Geology of Texas, Fourth Annual Rep.' (1892), with such modifications as it became necessary to make in the presence of the new material available.

For the Ammonoidea, here represented by the Goniatites, Hyatt's widely recognised classification has been adopted, though in the case of the largest and most important group, the Glyphioceratidæ, some changes have been introduced. Under his original description of *Glyphioceras* Hyatt divided the genus into two sections which he characterised, and to which he allotted certain species. To these unnamed sections I have given distinctive names as sub-genera, and following Perrin Smith,[1] have resuscitated *Muensteroceras*, also as a sub-genus, taking the suture-line in each case as the principal distinguishing feature (Synopsis of Families, Genera, etc., p. 219).

The retention of *Gastrioceras* as an independent genus, rather than the merging of it in *Glyphioceras*, as suggested by Karpinsky,[2] is held by Perrin Smith to be justified by the fact that *Gastrioceras* being a later branch than *Glyphioceras*, phylogenetic studies are facilitated by their separation, while there is no difficulty in distinguishing typical members of each group. *Gastrioceras* is therefore maintained in accordance with this view.

The most cursory survey of the material at present collected and recorded shows plainly what a rich molluscan fauna is contained in the rocks of the Carboniferous System spread over a great part of Ireland. It is a safe prediction that with more workers in the field much additional material might be gathered in, thereby greatly facilitating those studies which may lead to the most important results in all that relates to the phylogeny of the Cephalopoda, and the important biological and faunal questions they help to elucidate; for, as it has been truly stated, "the Cephalopoda alone, of all animals, preserve in the individual a complete record of their larval and embryonic history, the protoconch and early chambers being enveloped and protected by the latter stages of the shell."[3] Hence the great importance that must be attached to the collection of many individuals of the same species to supply the means of carrying out such embryological work as has already

[1] 'Proc. California Acad. Sci.,' third ser., Geology, vol. i, No. 3, p. 105, 1897.

[2] 'Mém. Acad. Imp. Sci. St. Pétersbourg,' vol. xxxvii, p. 48, 1889.

[3] J. Perrin Smith, in 'Proc. Amer. Phil. Soc.,' vol. xxxv, 1896, p. 254.

been productive of very interesting results. I refer here especially to Perrin Smith's fruitful studies in the phylogeny of the Glyphioceratidæ.

It may excite some surprise in those who make use of this work that some of the species of Cephalopoda contained in the lists of Irish Carboniferous fossils published by M'Coy,[1] Kelly,[2] Baily,[3] and others, are entirely omitted from its pages. This omission has been found necessary (1) in cases in which the type specimen has been lost and the description found to be insufficient for purposes of identification, (2) more often when the identification of a species has been entirely mistaken. The latter applies to some of the species in the Griffith Collection to which names have been affixed without sufficient discrimination (*see* foot-note, p. 197). This has been rectified whenever the material was sufficiently well preserved to supply the data necessary for determining the species.

In comparing the Cephalopod fauna of the Belgian Carboniferous area with that of the British Isles, one cannot fail to notice how few species there are which are common to both. Considering the proximity of the two areas, this is remarkable and difficult to account for, except on the assumption that the physical conditions differed to such an extent as to give a distinctive specific facies, expressed in differing species in the respective areas.

Without having recourse to comparative tables it may be noted that the species common to the British Isles and Belgium are generally those which are at the same time the most abundant and characteristic of their kind in each area. Such species, *e.g.*, among the Nautiloids are *Orthoceras lævigatum*, F. M'Coy; *Actinoceras giganteum*, J. de C. Sowerby; *Stroboceras sulcatum*, J. de C. Sowerby, sp.; *Discitoceras Lecrilleanum*, L.G. de Koninck, sp.; *Aphelœceras mutabile*, F. M'Coy, sp.; *Vestinautilus paucicarinatus*, A. H. Foord. Among the Goniatites the following species may be enumerated in the same sense:—*Glyphioceras* (*Sphenoceras*) *striatum*, J. Sowerby, sp.; *G.* (*S.*) *sphæricum*, W. Martin, sp.; *G.* (*Beyrichoceras*) *truncatum*, J. Phillips, sp.

Of the rarer forms occurring in both areas the following may be cited:—*Trigonoceras paradoxicum*, J. de Sowerby, sp.; *Temnocheilus coronatus*, F. M'Coy.

Out of 126 species of Cephalopods described by de Koninck ('Calc. Carb.') only about 26 can be identified as occurring in the Irish area. An analysis of these figures shows that out of 52 species of the coiled Nautiloids 11 are common to Ireland and Belgium, of uncoiled ones 7 out of 11 are common to both countries, and of Goniatites 8 out of 33.

[1] 'Synopsis Carb. Foss. Ireland,' 1844.

[2] 'Journ. Geol. Soc. Dublin,' 1855–7, vol. vii.

[3] 'Mem. Geol. Surv. Ireland.'

II. Geology.

The divisions in the Carboniferous Limestone series of Ireland, though sometimes fairly well marked lithologically, are of doubtful value for purposes of zonal palæontology, as it is a question whether the "Lower," "Middle,"[1] and "Upper" divisions, as constituted, were actually synchronous throughout the country, or whether they may not have represented deposits of different character accumulated simultaneously in different districts, and depending upon the diverse physical conditions for their dissimilarity,—in fact, upon such variable results as might have been produced by shallower or deeper water.

As regards the beds above the so-called Upper Limestone, we have it on the joint authority of Dr. Wheelton Hind and Mr. J. A. Howe[2] that certain beds in the counties of Dublin and Limerick, at Westown[3] and on Foynes Island[4] respectively, belong to the Upper Limestone Shales, or Pendleside Group. The characteristic fauna found in them is held to supply "strong presumptive evidence of this view." It should be added that the beds at Westown were recognised by the officers of the Geological Survey to belong to the horizon now claimed for them; those of Foynes Island were, however, assigned to the Coal Measures. The species here tabulated are in the Dublin Museum of Science and Art, in the Geological Survey Collection.

The fauna at Westown comprises the following species:

Aviculopecten papyraceus.
„ *variabilis.*
Posidonomya membranacea.
[*Posidoniella lævis* ?.][5]
Lunulicardium [*Footi*].
Goniatites crenistria [*Glyph. spirale*].
„ *Listeri.*[6]
Orthoceras [*Steinhaueri*].
Dithyrocaris.

[1] Called also "Calp," a local term originally employed by Kirwan. This rock is a dark-coloured, or black, earthy limestone of a shaly or flaggy character.

[2] 'Quart. Journ. Geol. Soc.,' 1901, vol. lvii: "On the geological succession and palæontology of the beds between the Millstone Grit and the Limestone-Massif at Pendle Hill, and their equivalents in certain other parts of Britain," p. 376.

[3] 'Mem. Geol. Surv. Ireland,' Expl. sheets 102 and 112, 2nd ed., 1875, p. 60.

[4] Ibid., Expl. sheet 142, 1860, pp. 8—15.

[5] The names between square brackets were added by Dr. Wheelton Hind.

[6] The specimens labelled "Coal Measures, Westown, co. Dublin—*Goniatites Listeri*," are too much crushed to be specifically recognisable, but there are features in them which would amply suffice to exclude them from that species; one of these is a very distinct spiral groove or sulcus in the outer whorl, recalling *Glyphioceras bilingue;* the inner whorls are transversely ribbed. There are other fragments on the surface of the shale with tubercular ribbing; these last may have suggested affinities with *Gastrioceras Listeri*, but I am unable to confirm this view, the presence of the sulcus being fatal to it and rather supporting the idea of a species with compressed whorls. No trace of the suture-line is seen in any of the specimens that I have met with in these shales.

The fauna on Foynes Island is as follows:

Posidonomya Becheri.
Aviculopecten papyraceus.
Orthoceras minimum.
Goniatites [*Glyphioceras*][1] *reticulatus.*
„ *Listeri* [*Gastrioceras circumplicatile*].
Nautilus tuberculatus [?].

The following divisions of the Carboniferous System of Ireland are those at present recognised by the Geological Survey, but it seems to be admitted that some of them need revision, and this they will doubtless undergo in course of time.

Middle Coal Measures.
Lower Coal Measures.
Millstone Grit.
Yoredale Series.
Upper Carboniferous Limestone.
Middle „ „
Lower „ „
Lower Limestone Shale or Basement Beds.

The list given below supplies the localities and horizons of the fossils described. I am indebted to Mr. Alexander M'Henry, M.R.I.A., and to Mr. Henry J. Seymour, B.A., F.G.S., for kindly verifying these, the former from the official registers, the latter from the geological maps.

Alphabetical List of the Localities referred to in the foregoing Descriptions of Fossils, with their Horizons.

Place.	*County.*	*Horizon.*
Ardgoul South	Limerick	Lower[2] Limestone.
Ardlaman	„	„ „
Ardtomin	„	„ „
Ballinacourty	Waterford	„ „
Ballycahane	Limerick	„ „
Ballyduff (Dungarvan)	Waterford	„ „
Ballynabointra	Cork (East Riding)	„ „
Ballynacarriga	Limerick	„ „
Ballyrichard	Cork	„ „
Bantry	„	„ „
Black Lion	Leitrim	Upper Limestone.
Blackrock (two miles east of Cork)	Cork	Lower Limestone.
Caher Lane	Limerick	Lower Coal Measures (Ganister).
Carnteel	Tyrone	Lower Limestone.

[1] The names, etc., between square brackets are added by the writer.

[2] The word "Carboniferous" after Lower, Middle, and Upper (Limestone) is omitted for the sake of brevity.

Place.	*County.*	*Horizon.*
Castle Espie	Down	Lower Limestone
Clane	Kildare	.. ..
Cliffs of Moher	Clare	Lower Coal Measures (Ganister).
Cloghran (two miles south of Swords)	Dublin	Lower Limestone.
Clonmel	Tipperary	.. ..
Cookstown	Tyrone	.. ..
Courtlough	Dublin	Middle Limestone.
Cragard	Limerick	Lower Limestone.
Cregg (near Nobber)	Meath	Upper Limestone.
Crosspatrick (Killala)	Mayo	Lower Limestone.
Curraghbridge (near Adare)	Limerick	.. ..
Derryloran	Tyrone	.. ..
Doneraile	Cork	.. ..
Doohyle (near Rathkeale)	Limerick	.. ..
Doon, Mt. Phelim (near Kilfendra)	Clare	Millstone Grit.
Drumsera (near Drumquin)	Tyrone	Middle Limestone.
Enniskillen (near the town)	Fermanagh	Lower Limestone.
Fanningtown	Limerick	.. ..
Florencecourt	Fermanagh	Middle Limestone.
Foynes Island	Limerick	Yoredale.
Garrihies	Kerry	Lower Limestone.
Garristown	Dublin	Middle Limestone.
Glenbane	Limerick	Lower Limestone.
Glenbane East	..	.. ..
Kilkommoch	Longford	.. ..
Killorglin	Kerry	.. ..
Kilmacat	Limerick	.. ..
Kilmallock	..	.. ..
Kinsale	Cork	Yoredale.
Lisbane	Limerick	Lower Limestone.
Lisdoonvarna	Clare	Coal Measures.
Lisnakerry	Limerick	Lower Limestone.
Little Island	Cork	.. ..
Loughrea (four miles east of)	Galway	.. ..
Loughshinny	Dublin	Upper Limestone, or Yoredale ?.
Midleton	Cork	Lower Limestone.
Mullaghfarry	Mayo	.. ..
Mullaghtinny (near Clogher)	Tyrone	.. ..
Naas	Kildare	.. ..
Nantenan	Limerick	.. ..
Newtown	Dublin	Middle Limestone.
Oldtown	Queen's	Lower Limestone.
Paget Priory (near Maynooth)	Meath	Yoredale.
Rathcahill	Limerick	Lower Coal Measures (Ganister).
Rathfarnham	Dublin	Middle Limestone.
Rathkeale	Limerick	Lower Limestone.
Ring	Fermanagh	.. ..

Place.	*County.*	*Horizon.*
Saint Doulagh's	Dublin	Lower Limestone.
Samphire Island	Kerry	Upper Limestone.
Shrule (near Ballymahon)	Londonderry	Lower Limestone.
Summerhill	Meath	Upper Limestone.
Tankardstown (near Kildorrery)	Cork	Lower Limestone.
Tomdeely	Limerick	,, ,,
Townparks (near Killeshandra)	Cavan	,, ,,

I cannot close this Monograph without expressing my sincere thanks to the authorities of the Geological Survey, the Museum of Science and Art, and the Royal College of Science for Ireland, for the loan of the fossils under their charge. Their kindness and liberality in placing the necessary material freely at my disposal, and also their indulgence to me in the matter of time, have greatly facilitated the completion of my task.

To the authorities of the British Museum (Natural History) I am equally indebted for their courtesy in according me all possible facilities for the study and illustration of the fossils contained in the Geological Department applicable to this Monograph.

ERRATA.

Part ii, 1898, p. 28, line 14 from top, *insert Locality.*—Clane, county of Kildare.

,, ,, p. 33, line 7 from bottom, *insert—Genus* CYRTOCERAS, *Goldfuss*, 1832.

Part iii, 1900, p. 60, line 18 from bottom, *for* Pl. XX, figs. 1—4, *read* Pl. XXVII, figs. 1—4.

,, ,, p. 97, line 13 from bottom, *for* "contracted" *read* "depressed."

,, ,, p. 118, line 17 from top, *for* vol. ix, *read* vol. iv.

,, ,, Plate XX, *Stroboceras sulcatum*, the numbering of figs. 11 and 12 require to be transposed.

INDEX.

Note.—Names of species which are regarded as synonyms or as invalid (and the pages on which they occur), whether contained in the tables of references or elsewhere in the text, also any species merely referred to incidentally in the text, are printed in *italics*.

ACANTHONAUTILUS, *118*, *121*, *122*, 216, *221*
bispinosus, 118, *121*
cornutus, *121*
ACTINOCERAS, *28*, *32*, 211, *221*
Bigsbyi, *32*
giganteum, 28, *29*, *30*, *31*, *32*, *223*
insulare, 30, *31*, *32*, *33*
propinquum, 33
pyramidatum, *28*
Simmsii, *28*
ACTINOCERATIDÆ, *28*, 211, *222*
Aganides:
diadema, *179*
fasciculatus, *136*
Henslowi, *202*, *203*
micronotus, *177*
obtusus, *163*
reticulatus, *183*
sphæricus, *155*, *173*
sphæricus, *var. β crenistria*, *158*
striatus, *157*, *160*
striolatus, *179*
subfurcatus, *135*
truncatus, *165*
AIPOCERAS, *116*, *131*, *132*, 216
compressum, 116
gibberosum, *117*
Hainesianum, 131
Ammonellipsites:
compressus, *202*
funatus, *134*
Ammonites, *221*
carbonarius, *154*
diadema, *179*, *180*
Henslowi, *68*, *202*, *203*, *204*, *205*
Listeri, *136*, *179*
micronotus, *177*
princeps, *134*
reticulatus, *183*
sphæricus, *154*, *155*, *158*, *160*, *163*, *173*
spiralis, *191*
striatus, *157*, *160*, *161*
truncatus, *165*
AMMONOIDEA, 132, 217
ANGULATA, *16*, 211
ANNULATA, *14*, 211
APHELECERAS, *65*, *72*, *73*, *118*, 214
difficile, *67*
APHELECERAS—
discoideum, *67*, *70*
exaratus, *71*
Hibernicum, 68, *70*
mutabile, 65, *66*, *67*, *68*, *69*, *70*, *223*
trochlea, *67*, 70, *71*, *72*
Apioceras:
fusiforme, 43
APPENDIX, 206
Ascoceras, *221*
ASYMPTOCERAS, *117*, *122*, *123*, *124*, 217
conspicuum, *125*
crassilabrum, 122, *123*, *125*, *132*
dorsale, *126*
Foordi, *123*, 124

BEYRICHOCERAS, s.g. (*see* Glyphioceras), *163*, *177*, 219
bilingue, 186
Browni, 175
cordatum, 188
corpulentum, 176
Davisi, 187
diadema, 179
difficile, 171

Beyrichoceras—
micronotum, 177
obtusum, 163
occidentale, 170
pulchellum, 190
reticulatum, 182
sphæroidale, 173
spirale, 191
subquadratum, 172
subreticulatum, 191
subtruncatum, 168
truncatum, 165
Brancoceras, *132*, *134*, *208*, *209*, 217
Enniskillenense, 208
ornatissimum, 132
rotatorium, *133*
Brevicones, 27, 211, *221*

Cephalopoda, *223*
Ceratites, *221*
Henslowi, *202*
Choanoceras, *221*
Clydonautilus, *221*
Clymenia, *221*
Cœlonautilus, *50*, *53*, *59*, *70*, *72*, *84*, *118*, 213
bistrialis, *115*
cariniferus, *82*
Doohylensis, 56
globatus, *96*
gradus, *55*, 57, *59*
hexagonus, *55*
multicarinatus, *93*
paucicarinatus, *86*
pinguis, *89*
planotergatus, *53*, 54, *55*, *56*, *58*, *59*
subsulcatus, *59*
Coloceras, *113*, *114*, 215
bistriale, *114*, 115, *116*
Coyanum, 113, *114*, *116*
globatum, *114*
Conchyliolithus Nautilites sphæricus, *154*
Concluding Remarks:
I. Palæontology, 220
II. Geology, 224
Conoceras, *221*
Coya, *123*
Cryptoceras:
dorsalis, *126*
Cycloceras:
lævigatum, *14*
Cylindriformes, *1*, 210
Cyrtoceras, *15*, *17*, *33*, *36*, *37*, *38*, *41*, *43*, 212
acinaces, *35*
(*Meloceras*) *acus*, *36*
æquale, *35*
Antilope, *36*
(Meloceras) apicale, 33, *34*, *37*
(*Meloceras*) *arachnoideum*, *36*
(Meloceras) arcuato-septatum, 37
Bailyi, *38*, *42*
concinnum, *35*
cornu, *35*, *36*
cornu-bovis, *36*
dactyliophorum, *15*
depressum, *35*
digitus, *35*, *36*
(*Meloceras*) *Gesneri*, *36*
hircinum, *35*
Hulli, *38*, *39*
ignotum, *35*
(*Meloceras*) *imperitum*, *36*
impotens, *35*
miles, *35*
nescium, *35*
Nysti, *35*
Puzosianum, *17*
(*Meloceras*) *repertum*, *36*
rostratum, *34*, *36*
(*Meloceras*) *rugosum*, *36*
Scharyi, *35*
(*Meloceras*) *Verneuilianum*, *36*
Cyrtoceratidæ, *33*, 212, *222*
Cyrtochoanites, *221*

Diorugoceras, *73*, 214
planidorsatum, 74
Discites, *53*, *204*
bisulcatus, *63*
compressus, *66*, *203*
Discites—
costellatus, *107*
discors, *104*
Hibernicus, *68*
mutabilis, *65*
oxystomus, *108*
(*Phacoceras*) *oxystomus*, *108*
planotergatus, *53*, *54*
sulcatus, *60*
Discitoceras, *50*, *102*, *107*, *110*, 216
costellatum, 107
discors, 104, *105*
Leveilleanum, 102, *103*, *104*, *105*, *106*, *223*
Wrightii, *104*, 105, *106*, *107*
Discocampyli, *221*

Ellipsolites:
compressus, *68*, *202*, *204*, *205*
ovatus, *163*, *165*
Ellipsolithes:
funatus, *134*
Endoceras, *32*, *221*
Eurycampyli, 217, *221*
Eusthenoceras, *36*, 38, *41*, 212
Bailyi, *39*, *40*, *41*, 42, *43*
Huili, *38*, 39, *40*, *41*, *42*
Extrasiphonata, *221*

Gastrioceras, *196*, *198*, 219
carbonarium, *197*, *199*, *200*
circumnodosum, 196, *197*, *198*
circumplicatile, 200, *201*, *202*
coronatum, *197*, *199*
diadema, *180*
fasciculatum, *136*
Gibsoni, *183*
Jossæ, *197*, *201*
Listeri, *197*, *198*, *199*, *200*, *201*, *224*
Marianum, *198*, *201*, *202*
Gastrocampyli, *221*
Globites:
ovatus, *163*
sphæricus, *154*
striatus, *160*

GLYPHIOCERAS, *154*, *181*, 218
(Beyrichoceras) bilingue, 186, *187*, *188*, *224*
(Beyrichoceras) Browni, *174*, 175
calyx, *200*
carbonarium, *155*
complanatum, *171*
(Beyrichoceras) cordatum, 188, *189*
(Beyrichoceras) corpulentum, 176
(Münsteroceras) crassum, 193
(Sphenoceras) crenistria, 157, *158*, *200*
cf. crenistria, *158*
(Beyrichoceras) Davisi, *184*, *187*, 187, *189*, *190*
(Beyrichoceras) diadema, 179, *180*, *181*, *182*
(Beyrichoceras) difficile, *168*, 171, *172*, *173*
(Münsteroceras) ellipsoidale, 194, *195*, *196*
excavatum, *181*, *184*
Hispanicum, *171*, *172*
inconstans, *169*
(Beyrichoceras) micronotum, 177, *178*
mutabile, *209*
(Münsteroceras) obesum, *195*, 196
(Beyrichoceras) obtusum, 163, *164*, *169*
(Beyrichoceras) occidentale, *168*, 170
parallelum, *194*
Phillipsi, *164*, *181*
(Beyrichoceras) pulchellum, *188*, 190
(Beyrichoceras) reticulatum, 182, *183*, *185*, *187*, *188*, *189*, *190*, *191*, *225*
rotella, *170*, *171*
(Sphenoceras) sphæricum, 154, *155*, *156*, *162*, *174*, *223*
(Beyrichoceras) sphæroidale, 173, *174*
GLYPHIOCERAS—
(Beyrichoceras) spirale, 191, *192*, *193*, *224*
stenolobum, *210*
(Sphenoceras) striatum, *157*, *159*, 160, *161*, *192*, *193*, *195*, *200*, *223*
(Beyrichoceras) subquadratum, *168*, 172, *173*
(Beyrichoceras) subreticulatum, 184, *188*
(Beyrichoceras) subtruncatum, *167*, 168, *169*, *171*
(Beyrichoceras) truncatum, 165, *166*, *167*, *168*, *169*, *172*, *173*, *177*, *178*, *181*, *223*
GLYPHIOCERAS, sp., 209, 210
GLYPHIOCERATIDÆ, *132*, 217
Gomphoceras, *45*, *221*
fusiforme, *43*, *48*
lagenale, *48*
sulcatulum, *48*
Goniatites, *193*, *221*, *222*, *223*
Baylei, *192*
Beyrichianus, *179*
bilinguis, *186*
Browni, *152*, *157*, *175*
crenistria, *157*, *158*, *159*, *183*, *202*, *224*
diadema, *179*, *180*
discus, *202*, *205*
excavatus, *209*
fasciculatus, *135*, *136*, *137*
funatus, *134*
furcatus, *136*
Gibsoni, *182*, *183*, *184*
granosus, *191*, *193*
Henslowi, *202*, *203*
(*Prolecanites*) *Henslowi*, *203*
(*Pericyclus ?*) *impressus*, *139*
jugosus, *182*, *183*
Listeri, *179*, *224*, *225*
micronotus, *177*, *178*
obtusus, *163*, *164*
ornatissimus, *132*, *134*
ovatus, *163*
plicatilis, *143*, *150*
princeps, *134*
Goniatites—
reticulatus, *182*, *183*, *225*
sphæricus, *154*, *155*, *156*, *157*, *158*, *160*, *175*
(*Glyphioceras*) *sphæricus*, *155*, *156*
sphæricus, *var. crenistria*, *134*
sphæroidalis, *173*, *175*
spiralis, *157*, *191*, *192*
spurius, *202*
striatus, *157*, *158*, *160*, *161*, *175*, *191*
striolatus, *179*, *180*
truncatus, *75*, *165*, *166*
(*Pericyclus ?*) *virgatus*, *139*
vittiger, *157*
Wrightii, *151*
GROUP OF—
Apheleceras mutabile, 65
Cœlonautilus planotergatus, 53
Glyph. (Beyr.) reticulatum, 182
Glyphioceras (Beyr.) truncatum, 165
Stroboceras sulcatum, 60
Grypoceratidæ, *208*
Gyroceras, *51*
(*Aipoceras*) *compressum*, *116*
Hibernicum, *101*
paradoxicum, *51*
(*Trigonoceras*) *paradoxicum*, *51*

Hercoceras, *207*, *221*
Hercoglossa, *110*
Holochoanites, *221*

IMBRICATA, *21*, 211
Intrasiphonata, *221*

Leptocampyli, *221*
LINEATA, *17*, 211
Lituites, *221*
Localities and Horizons, 225
LÆVIA, *1*, 210
LONGICONES, *1*, 210, *221*
Loxoceras, *221*

Medlicottidæ, *221*
Meloceras, s.g. (*see* Cyrtoceras), 212
apicale, 33
arcuatoseptatum, 37
Mesocampyli, *221*
Mesoceras, *221*
Mesochasmoceras, 72, *73*, 214
latidorsatum, 73
Microcampyli, *221*
Mixochoanites, *221*
Moniliformes, *12*, 211
Muensteroceras, s.g. (*see* Glyphioceras), *177*, *193*, *194*, *195*, 219
crassum, 193
ellipsoidale, 194
obesum, 196
parallelum, *194*
reticulatum, *183*
truncatum, *166*

Nautellipsites:
ovatus, *163*
Nautilites, *160*
Nautiloidea, 1, *193*, 210, *221*, *222*
Nautilus, *50*, *70*, *123*, *130*, *204*, *221*
atlantoideus, *97*
Barrandei, *207*
biangulatus, *50*, *82*
bistrialis, *115*
(*Temnocheilus*) *bistrialis*, *115*
bisulcatus, *63*
cariniferus, *82*, *86*, *88*
(*Temnocheilus*) *cariniferus*, *82*
complanatus, *109*
compressus, *202*, *203*
(*Discites*) *compressus*, *203*
cornutus, *120*
coronatus, *49*
(*Temnocheilus*) *coronatus*, *49*
(*Discites*) *costellatus*, *107*
Coyanus, *113*
discors, *104*
(*Discites*) *discors*, *104*
dorsalis, *126*, *127*, *128*, *132*
Nautilus—
excavatus, *82*
Freieslebeni, *121*
funatus, *134*
furcatus, *137*
globatus, *96*, *115*, *116*
(*Temnocheilus*) *globatus*, *96*
hexagonus, *55*
Hibernicus, *113*
latidorsatus, *73*
latus, *50*
Mosquensis, *68*
multicarinatus, *86*, *93*
(*Discites*) *mutabilis*, *65*, *66*
ovatus, *163*
oxystomus, *108*
(*Discites*) *oxystomus*, *108*
perplanatus, *165*
pinguis, *89*
(*Temnocheilus*) *pinguis*, *113*
planidorsatus, *74*
planotergatus, *53*
(*Discites*) *planotergatus*, *53*
(*Temnocheilus*) *porcatus*, *93*, *95*
Rouillieri, *110*
Seebachianus, *121*
subsulcatus, *68*
sulcatus, *60*, *62*, *63*, *64*, *75*
(*Discites*) *sulcatus*, *60*
sulcifer, *62*
sulciferus, *82*
trochlea, *70*
(*Discites*) *trochlea*, 70
tuberculatus, *50*, *225*
Noritidæ, *221*

Oncoceras, *48*
Ooceras, *221*
Orbulita:
sphærica, *154*
striata, *160*
Orthocera:
cordiformis, *47*
cylindracea, *7*
fusiformis, *43*
gigantea, *28*
paradoxica, *51*
Orthoceras, *1*, *36*, *38*, *41*, 210, *221*
acre, 6, *10*, *11*
amabile, 8
annulatum, *14*
Breynii, *13*
calamus, 9
cinctum, *22*, 26, *27*
Clanense, 21, *22*, *23*, *25*
Colei, 3, *4*, *5*,
conquestum, *18*
cordiforme, *28*
cucullus, *27*, *28*
cyclophorum, *15*
cylindraceum, 7, *11*
dactyliophorum, *14*
dilatatum, *28*
discrepans, *18*
(*Loxoceras*) *distans*, *25*
fandum, *5*
fusiforme, *43*
giganteum, *28*, *29*
(*Actinoceras*) *giganteum*, *28*
Hibernicum, 19, *36*
Hindei, 12, *13*, *14*
inopinatum, *6*
Kildarense, 17
lævigatum, 14, *15*, *223*
latissimum, *28*, *46*, *47*
Leinsterense, 1, *3*, *4*
lineale, *20*
Morrisianum, *22*
multistriatum, *10*, 24, *25*
Nerviense, *6*, *7*, 8
oblique-annulatum, *15*
paradoxicum, *51*
(*Trigonoceras*) *paradoxicum*, *51*
perapproximatum, 11
perconicum, 27, *28*
perellipticum, *24*, 25
pilum, *12*, 13
Porteri, 9, *11*
princeps, *3*
pulcherrimum, 19
Puzosianum, *16*
salutatum, *18*
salvum, *18*, 18, *57*

Orthoceras—
Sancti-Doulaghi, 5, *6*
Sollasi, 23, *25*
Steinhaueri, *224*
(*Actinoceras*) *striatum*, *19*, *20*
subclavatum, *12*, 13, *14*
undatum, *15*
unguis, *33*
variabile, *2*, 2
venabulum, 10
vicinale, *22*
Wrightii, 16, *17*
Orthoceratidæ, 1, 210
Orthoceratites:
subfusiformis, *48*
subpyriformis, *48*
Orthocères brévicones, *28*
Orthochoanites, *221*

Pachycampyli, *221*
Pericyclus, *134*, *152*, *154*, 218
Bailyi, *142*, 147, *148*, 149
Clanensis, 151, *152*, *154*
Doohylensis, *57*, *137*, 138, *139*, *140*
fasciculatus, *134*, 135, *136*, *137*, *140*, *151*, *197*
Foordi, 141, *142*, *143*, *144*, *147*, *148*, *149*
funatus, 134, *136*, *137*, *151*
furcatus, *136*, *151*
Hauchecornei, *151*
Kochi, *139*
Leesoni, *152*, 153
multicostatus, *137*, 139, *140*
plicatilis, *135*, 150, *151*
princeps, *152*
rotuliformis, *142*, *146*, *147*, 148, *149*
subplicatilis, 142, *143*, *144*, *148*, *151*
trapezoidalis, 144, *146*
virgatus, *152*
Phacoceras, *108*, *110*, 216
oxystomum, 108, *111*, *112*
rectisuturale, 111
Phragmoceras, *221*
Phyllocampyli, 220, *221*
Pilloceras, *32*, *221*
Planetoceras, *96*, 215
globatum, 96, *116*
retardatum, *97*
Planites:
compressus, *202*
Potrioceras, *28*, *43*, *45*, *48*, 213, *221*
approximatum, *48*
cordiforme, *46*, *48*
ellipsoideum, *48*
fusiforme, *43*, *44*, *45*, *46*, *48*
heteroclitum, *48*
latiseptatum, *44*, 45, *48*
lumbrosum, *48*
Marri, 48
vasiforme, *48*
ventricosum, 46, *48*
Potrioceratidæ, *43*, 212, *222*
Prolecanites, *68*, *154*, *202*, *204*, 220
ceratitoides, *204*
compressus, 202, *203*
Henslowi, *203*
Leesoni, *153*
similis, *204*
Prolecanitidæ, 220, *221*
Pronorites:
cyclolobus, *198*

Rhineceras, *102*
Hibernicum, *101*
Rhineceratidæ, *98*, 216

Schistochoanites, *221*
Solenocheilidæ, *116*, *117*, *122*, *130*, 216
Solenocheilus, *117*, *126*, *129*, *130*, *132*, *207*, *208*, 217, *221*
atlantoideus, *129*
clausus, 130, 207
conspicuus, *124*
dorsalis, 126, *127*, *129*
evolutus, *127*, *128*
Hibernicus, 128, *129*, *131*
latiseptatus, *127*
Sphenoceras, s.g. (*see* Glyphioceras), *154*, 218
crenistria, 157
Sphenoceras—
sphæricum, 154
striatum, 160
Stroboceras, *57*, *59*, *60*, *73*, 214
Belgicum, *62*, *64*
bisulcatum, *61*, *63*, *64*
cordiostomum, *64*
crassum, 64
Edwardsianum, *64*
germanum, *64*
gradus, *57*
Phillipsianum, *64*
sulcatum, 60, *61*, *64*, *65*, *223*
Subclymenia, *73*
Synopsis of Families, Genera, and Species, 210
Syringoceras, *207*, *208*
granulosostriatum, *207*

Tainoceratidæ, *49*, 213
Temnocheilus, *49*, *206*, 213
coronatus, 49, *50*, 206, *223*
crenatus, *75*, *77*
furcatus, *136*
globatus, *96*
multicarinatus, *93*
pinguis, *113*
tuberculatus, *50*
Terebrirostra, *123*
Thrincoceras, *98*, *102*, 216
depressum, *100*
Hibernicum, *99*, 101, 102
Hyatti, 98, *99*, *100*, *102*
Kentuckiense, *99*, *100*
Trachyceras:
Aonoides, *208*
Tribloceras, *75*, *77*, *78*, 215
consobrinum, *78*
formosum, 75, *77*, *78*, *79*
intermedium, *78*
Meyerianum, *77*, *78*
serratum, *78*
Tribloceratidæ, *75*, 215
Trigonoceras, *51*, *52*, *53*, *59*, *72*, *118*, 213
aigoceras, *52*, *118*
paradoxicum, 51, *52*, *53*, *118*, *223*
Trigonoceratidæ, *51*, *72*, 213

VESTINAUTILUS, *77*, *78*, *79*, *84*, *92*, *114*, *123*, 215, *221*
cariniferus, *81*, 82, *84*, *85*, *86*, *87*, *88*, *94*, *113*, *114*
cariniferus, var. magnicameratus, 84
VESTINAUTILUS—
cariniferus, var. triplicatus, 112
cariniformis, *78*, *80*
crassimarginatus, 79, *81*
crateriformis, *84*, 85
Koninckii, *78*
multicarinatus, 93
VESTINAUTILUS—
paucicarinatus, *83*, *84*, 86, *90*, *91*, *92*, *95*, *223*
pinguis, *88*, 89, *90*, *95*
semiglaber, *77*, 78
semiplicatus, 91, *92*

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PLATE I.[1]

Orthoceras Leinsterense, *A. H. Foord.*

Fig. 1 *a*. Specimen showing the body-chamber and much of the septate part of the shell. 1 *b*. Longitudinal section of the same, showing the septa and the position of the siphuncle. 1 *c*. Convex surface of one of the septa showing the siphuncle. These figures are somewhat more than one half of the natural size. Clane. Dublin Museum of Science and Art. (Page 1.)

Orthoceras variabile, *A. H. Foord.*

Fig. 2 *a*. Specimen with body-chamber and nearly all of the septate part; the latter has been polished to show the septa. 2 *b*. Longitudinal section showing the septa and a fragment of the siphuncle. 2 *c*. Transverse section with siphuncle. 2 *d*. The same, near the apex. These figures are somewhat more than one half of the natural size. Clane. Dublin Museum of Science and Art. (Page 2.)

Orthoceras Sancti-Doulaghi, *A. H. Foord.*

Fig. 3 *a*. Fragment of the septate part of a large specimen. 3 *b*. Longitudinal section, showing the septa and the position of the siphuncle. 3 *c*. Transverse section with siphuncle. 3 *d*. Fragment of a smaller specimen, showing the body-chamber. 3 *e*. Transverse section of the same, showing the siphuncle. St. Doulagh's. Dublin Museum of Science and Art. (Page 5.)

[1] All the figures in this and the following plates are of the natural size, except where otherwise stated.

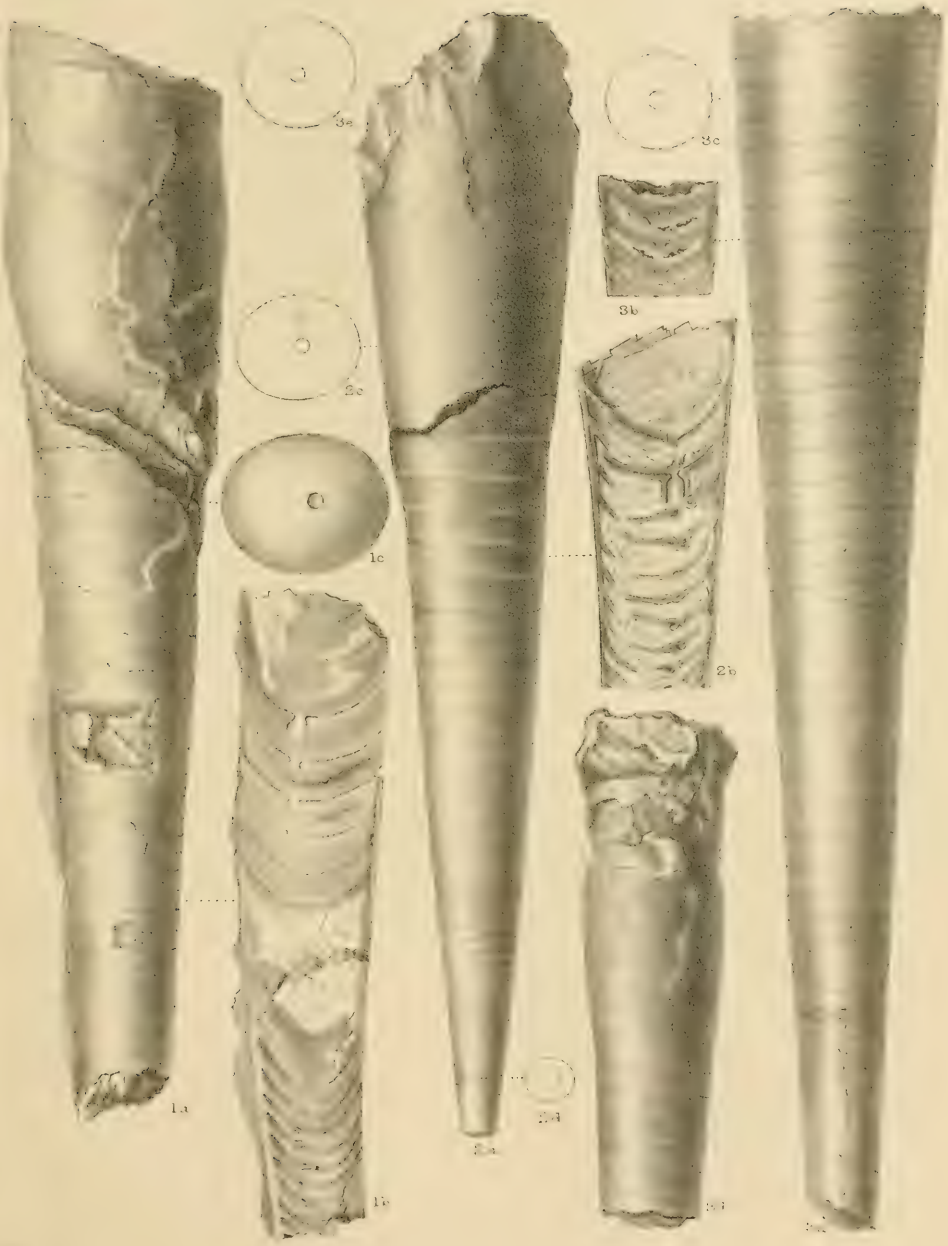

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PLATE II.

Orthoceras Colei, *A. H. Foord.*

Fig. 1 *a*. Fragment showing part of the body-chamber and septate part of the shell. 1 *b*. Longitudinal section of the same, showing the septa and siphuncle. 1 *c*. Transverse section of the same. Clane. Dublin Museum of Science and Art. (Page 3.)

Orthoceras acre, *A. H. Foord.*

Fig. 2 *a*. Specimen wanting a portion of the body-chamber, but perfect at the apex. 2 *b*. The apical portion of 2 *a*, separated from it to avoid reduction of the figure. 2 *c*. Apical extremity greatly enlarged. 2 *d*. Transverse section, showing the siphuncle. Little Island. Dublin Museum of Science and Art. (Page 6.)

Orthoceras perapproximatum, *A. H. Foord.*

Fig. 3. Specimen showing the very numerous septa. Clane. Dublin Museum of Science and Art. (Page 11.)

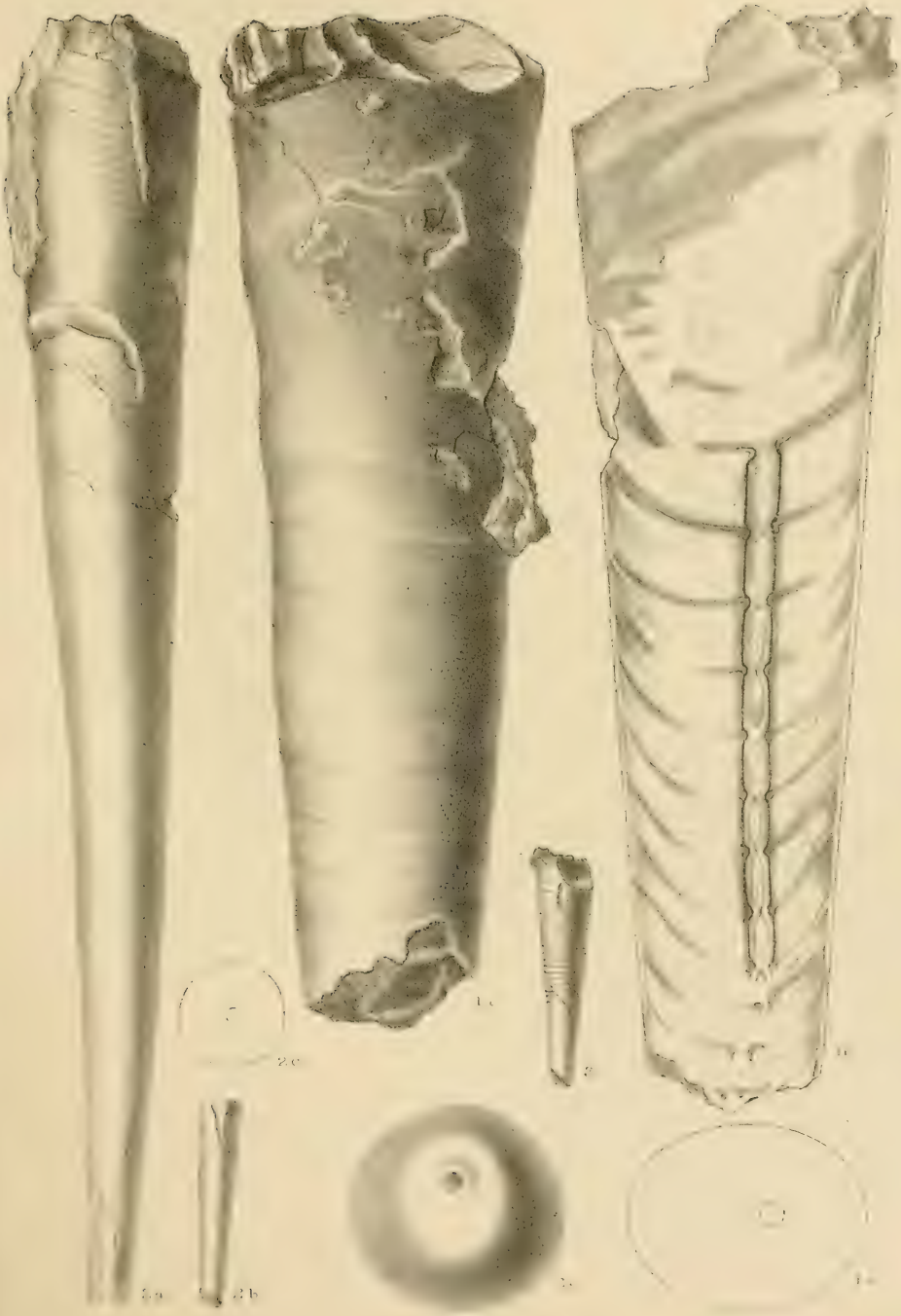

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PLATE III.

ORTHOCERAS NOLANI, *A. H. Foord.*

Figs. 1 *a*, 1 *b*, 1 *c*. A large specimen covered with the test, the figure divided into three portions to avoid the necessity of reducing it. 1 *d*. Longitudinal section of the same. 1 *e*. Longitudinal section of another individual. 1 *f*. Transverse section of the same along the longer diameter, and showing the excentric siphuncle. Clane. Dublin Museum of Science and Art. (Page 4.)

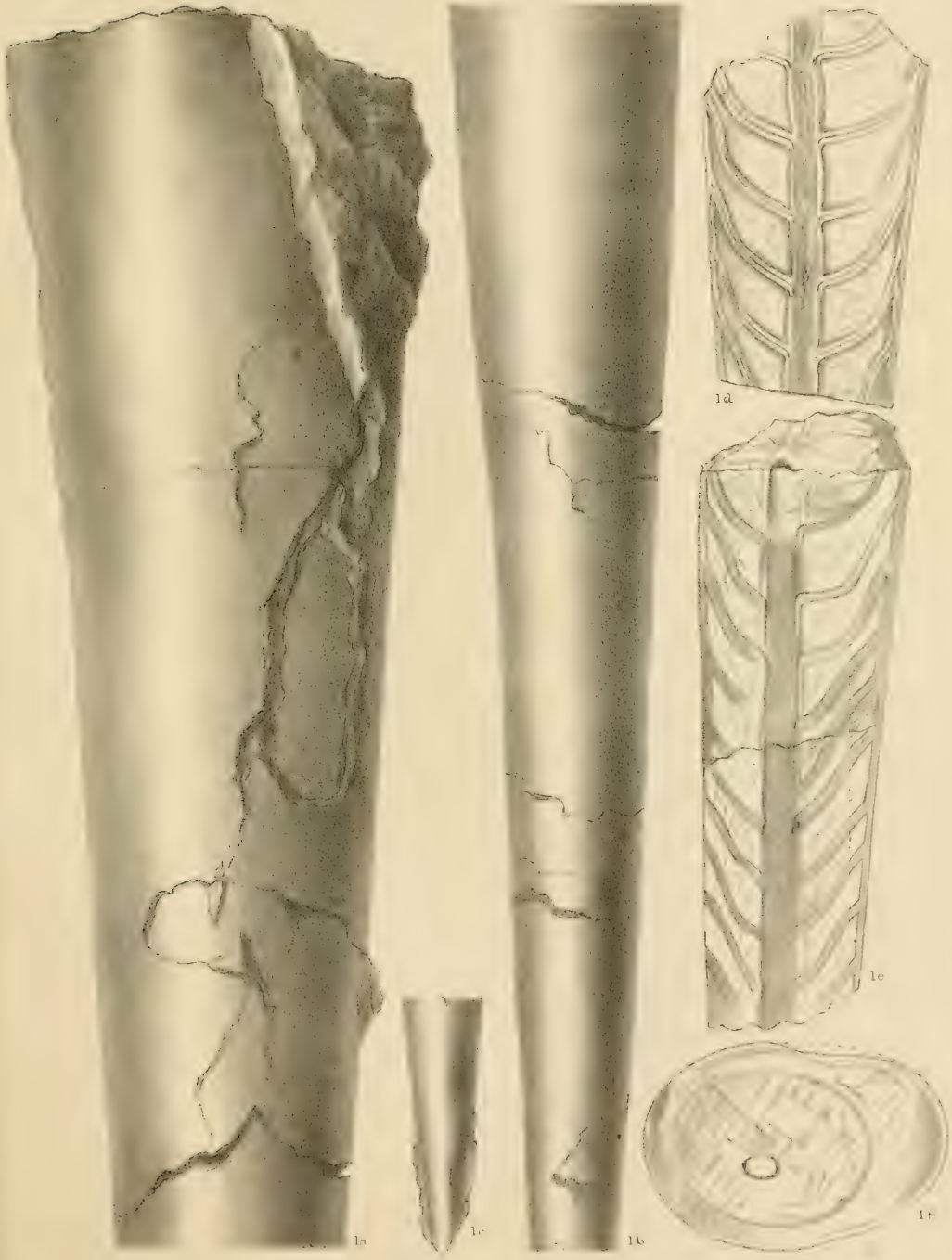

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PLATE IV.

Orthoceras Porteri, *A. H. Foord.*

Fig. 1 *a*. Fragment with the greater part of the body-chamber. 1 *b*. Transverse section of the same. 1 *c*. Body-chamber of another individual. 1 *d*. Longitudinal section of another specimen. Little Island. Dublin Museum of Science and Art. (Page 9.)

Orthoceras subclavatum, *A. H. Foord.*

Fig. 2 *a*. A nearly complete specimen, showing the wavy and oblique septa. 2 *b*. Transverse section. 2 *c*. Longitudinal section of another individual, showing the beaded siphuncle. Little Island. Dublin Museum of Science and Art. (Page 13.)

Orthoceras venabulum, *A. H. Foord.*

Figs. 3 *a*, 3 *b*. Specimen with the surface slightly polished to show the septa. The extremity has been separated from the rest of the specimen in order to represent the latter of the natural size. 3 *c*. Longitudinal section from the same individual. 3 *d*. Transverse section, showing the siphuncle. Clane. Dublin Museum of Science and Art. (Page 10.)

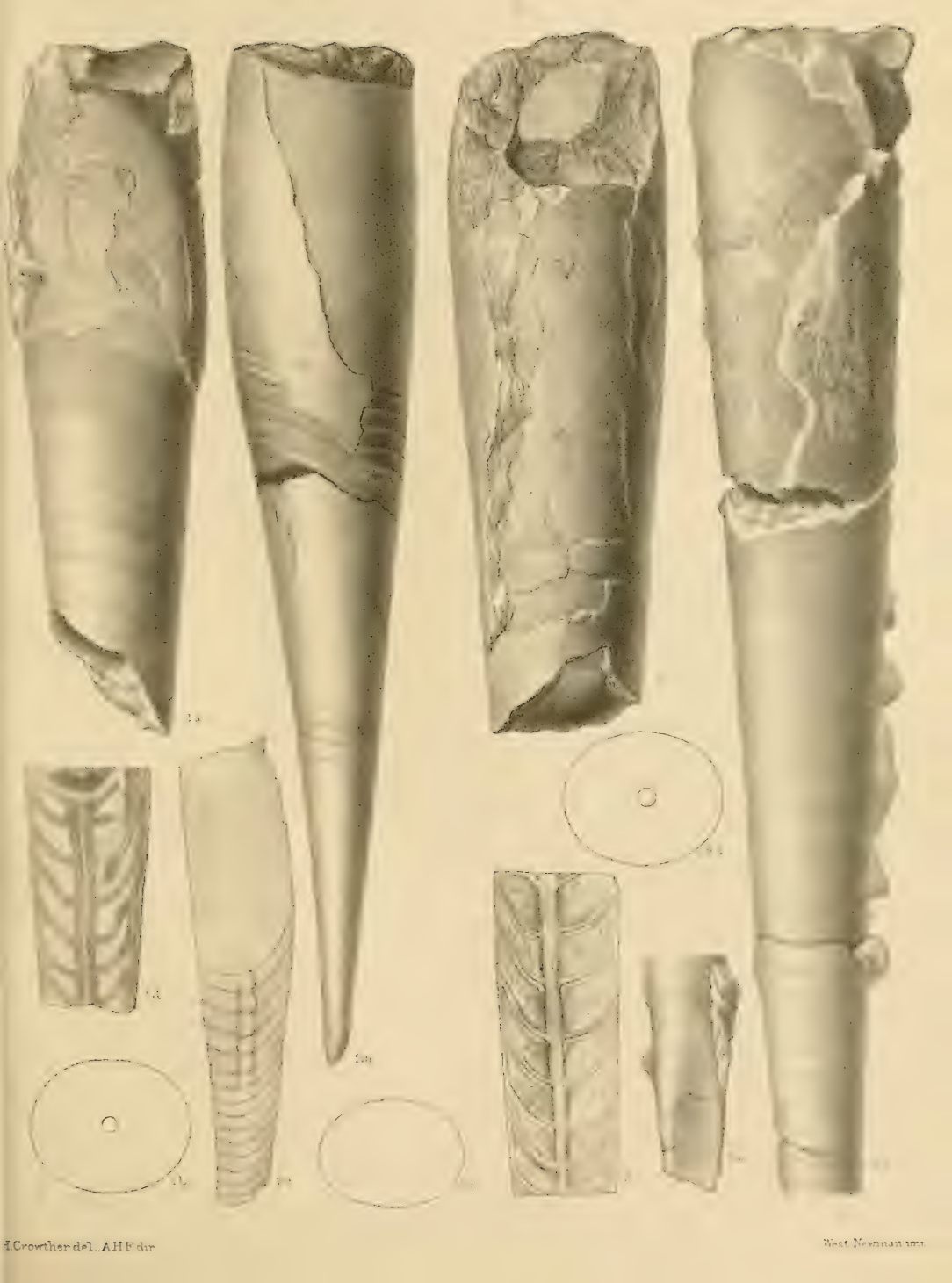

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PLATE V.

Orthoceras lævigatum, *F. M'Coy.*

Fig. 1 *a*. Cast of an individual of which a portion has been lost. 1 *b*. A septum of the same, showing the siphuncle. 1 *c*. Fragment of another specimen. 1 *d*. Fragment with part of the test, showing transverse striæ. 1 *e*. A portion of the test of the same specimen enlarged. Ardlaman. Dublin Museum of Science and Art (Geological Survey of Ireland Collection). (Page 14.)

Orthoceras Wrightii, *S. Haughton.*

Fig. 2 *a*. The type specimen, showing the ornamentation. 2 *b*. Body-chamber of the same, showing at the base the obliquity of the septa. 2 *c*. Ornamentation of the surface, much enlarged. 2 *d*. Septum showing the siphuncle. Clonmel. In the Collection of Mr. Joseph Wright, F.G.S., of Belfast. 2 *e*. The specimen from Clane, drawn for comparison with 2 *a*. Dublin Museum of Science and Art. (Page 16.)

Orthoceras pilum, *A. H. Foord.*

Fig. 3 *a*. Specimen showing the septate part only, imperfect at both ends. 3 *b*. The last septum preserved, showing the siphuncle. Little Island. Dublin Museum of Science and Art. (Page 13.)

Orthoceras Hindei, *A. H. Foord.*

Fig. 4 *a*. Fragment consisting of nearly the whole of the body-chamber, with a few septa attached. 4 *b*. Longitudinal section of the same, showing the siphuncle. 4 *c*. Transverse section of the same. Little Island. Dublin Museum of Science and Art. (Page 12.)

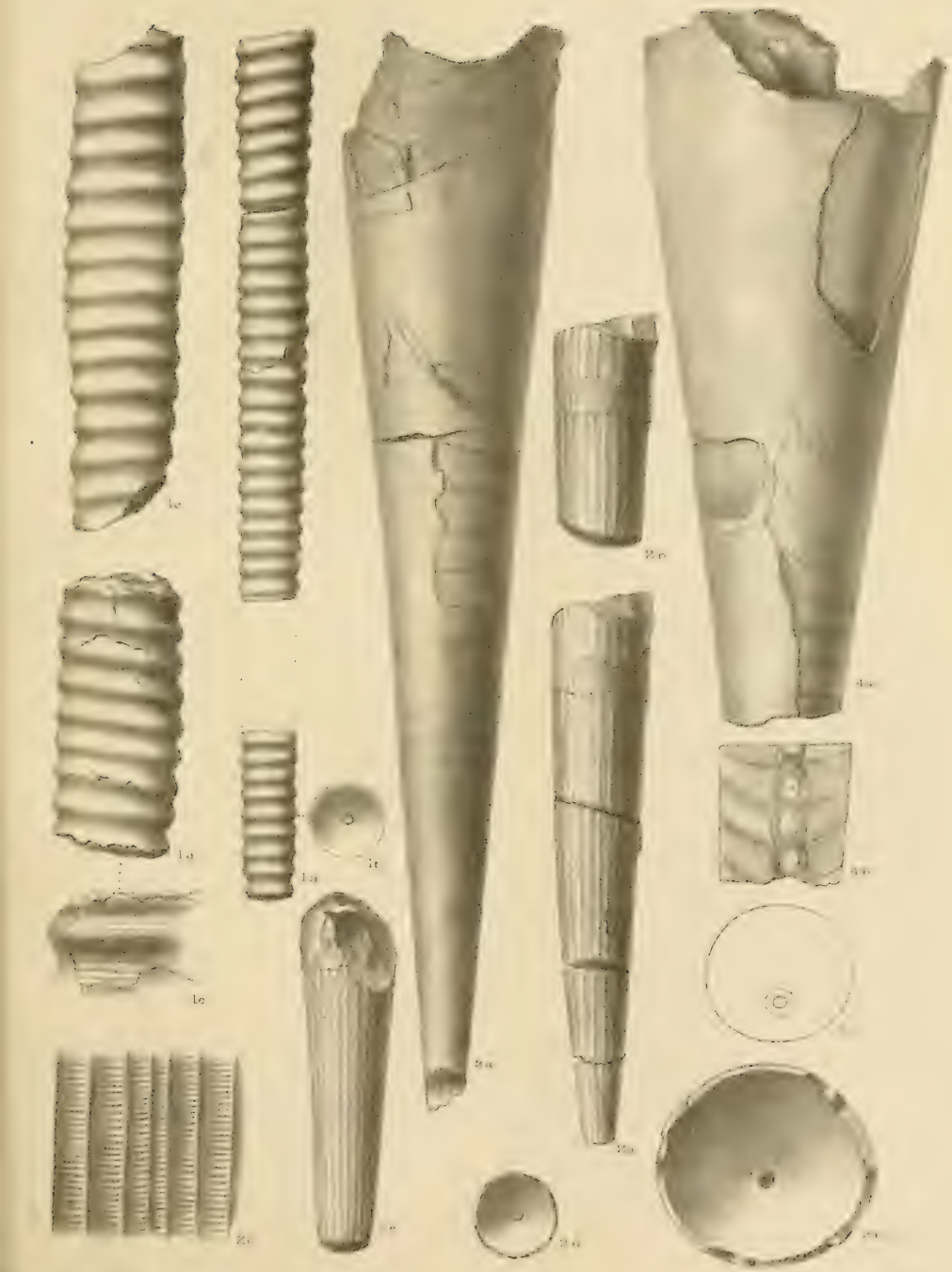

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PLATE VI.

Orthoceras hibernicum, *A. H. Foord.*

Fig. 1 *a*. Specimen almost entirely covered with the test. 1 *b*. Longitudinal section of the same, showing in the lower part the somewhat inflated siphuncle. 1 *c*. Septum showing the siphuncle. 1 *d*. The same nearer the apical end. 1 *e*. The ornamentation enlarged. Clane. Dublin Museum of Science and Art. (Page 19.)

Orthoceras pulcherrimum, *A. H. Foord.*

Fig. 2 *a*. Fragment consisting of nearly the whole of the body-chamber and some of the septa. 2 *b*. Longitudinal section of the same. 2 *c*. Portion of the test greatly magnified. Clane. Dublin Museum of Science and Art. (Page 19.)

Orthoceras Kildarense, *A. H. Foord.*

Fig. 3 *a*. Fragment composed of the body-chamber and five septal chambers. 3 *b*. Section of the same showing the siphuncle. 3 *c*. Fragment of another individual, with part of the test preserved. 3 *d*. Part of the test enlarged. Clane. Dublin Museum of Science and Art. (Page 17.)

Orthoceras salvum, *L. G. de Koninck.*

Fig. 4 *a*. Specimen completely covered with the test. 4 *b*. The test magnified. Doohyle. Dublin Museum of Science and Art. (Page 18.)

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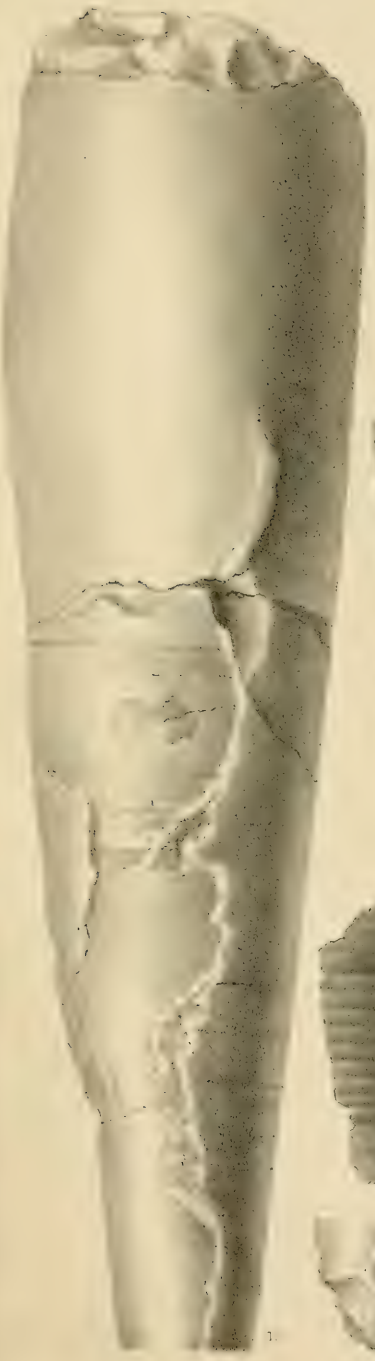
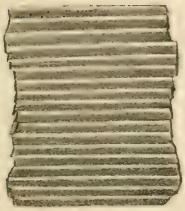
PLATE VII.

Orthoceras Clanense, *A. H. Foord.*

Figs. 1 *a*, 1 *b*. Specimen showing body-chamber and a considerable portion of the septate part of the shell. 1 *b*. The lower part of 1 *a*. 1 *c*. Another specimen, showing the oblique septa and the fine striæ at the upper part. 1 *d*. Transverse section of the same. 1 *e*. Portion of the test of the same, greatly magnified, showing the imbricating character of the striæ. 1 *f*. The same, somewhat diagrammatic. 1 *g*. Apical portion of another individual, showing the beaded siphuncle of the young shell. Clane. Dublin Museum of Science and Art. (Page 21.)





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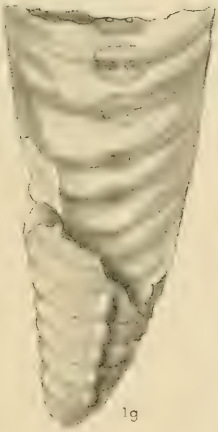

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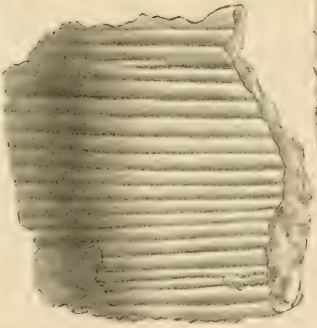
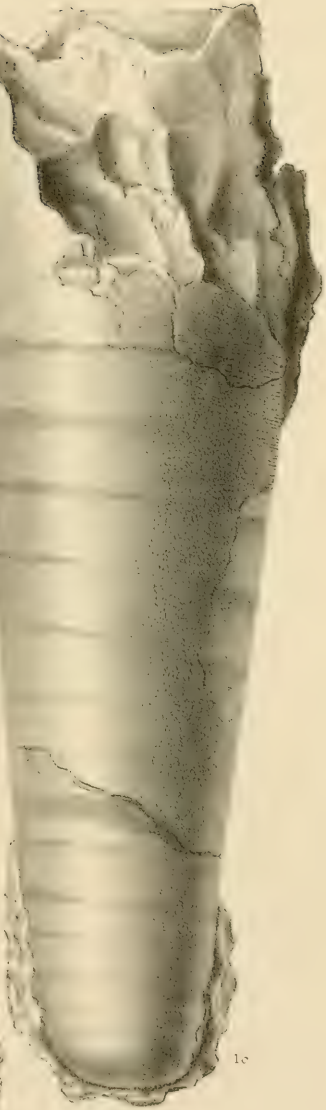
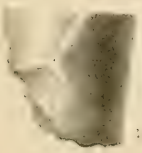


1e



1c



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1d

PLATE VIII.[1]

Orthoceras Sollasi, *A. H. Foord.*

Fig. 1 *a*. Specimen showing the body-chamber and the greater part of the septate portion of the shell. (Note the crescentic depression at the anterior end of the body-chamber just below the margin of the aperture.) 1 *b*. Transverse section with siphuncle. 1 *c*. Portion of the test showing the striæ, natural size. 1 *d*. Figure of the striæ (somewhat diagrammatic), enlarged to show bifurcations. 1 *e*. Another specimen, somewhat more complete than 1 *a*, showing the septa where the test is removed; the slight constriction near the aperture is well seen. 1 *f*. Longitudinal section showing septation and a fragment of the siphuncle. Clane. Dublin Museum of Science and Art. (Page 23.)

Orthoceras multistriatum, *A. H. Foord.*

Fig. 2 *a*. Fragment with body-chamber and a good deal of the septate part of the shell. 2 *b*. Longitudinal section showing the septa and siphuncle. Little Island. Dublin Museum of Science and Art. (Page 24.)

Orthoceras perellipticum, *A. H. Foord.*

Fig. 3 *a*. Fragment of the septate part of a specimen. 3 *b*. Transverse section showing siphuncle. 3 *c*. Imbricating striæ greatly enlarged. Little Island. Museum of Queen's College, Cork. (Page 25.)

Orthoceras perconicum, *A. H. Foord.*

Fig. 4 *a*. Fragment showing the greater part of the body-chamber and some of the septa. 4 *b*. Transverse section, the siphuncle not preserved. Clane. Dublin Museum of Science and Art. (Page 27.)

[1] All the figures in this and the following Plates represent the specimens of the natural size unless the contrary is stated.

W.H.Crowther lith. A.H.F. del.

West, Newman imp.

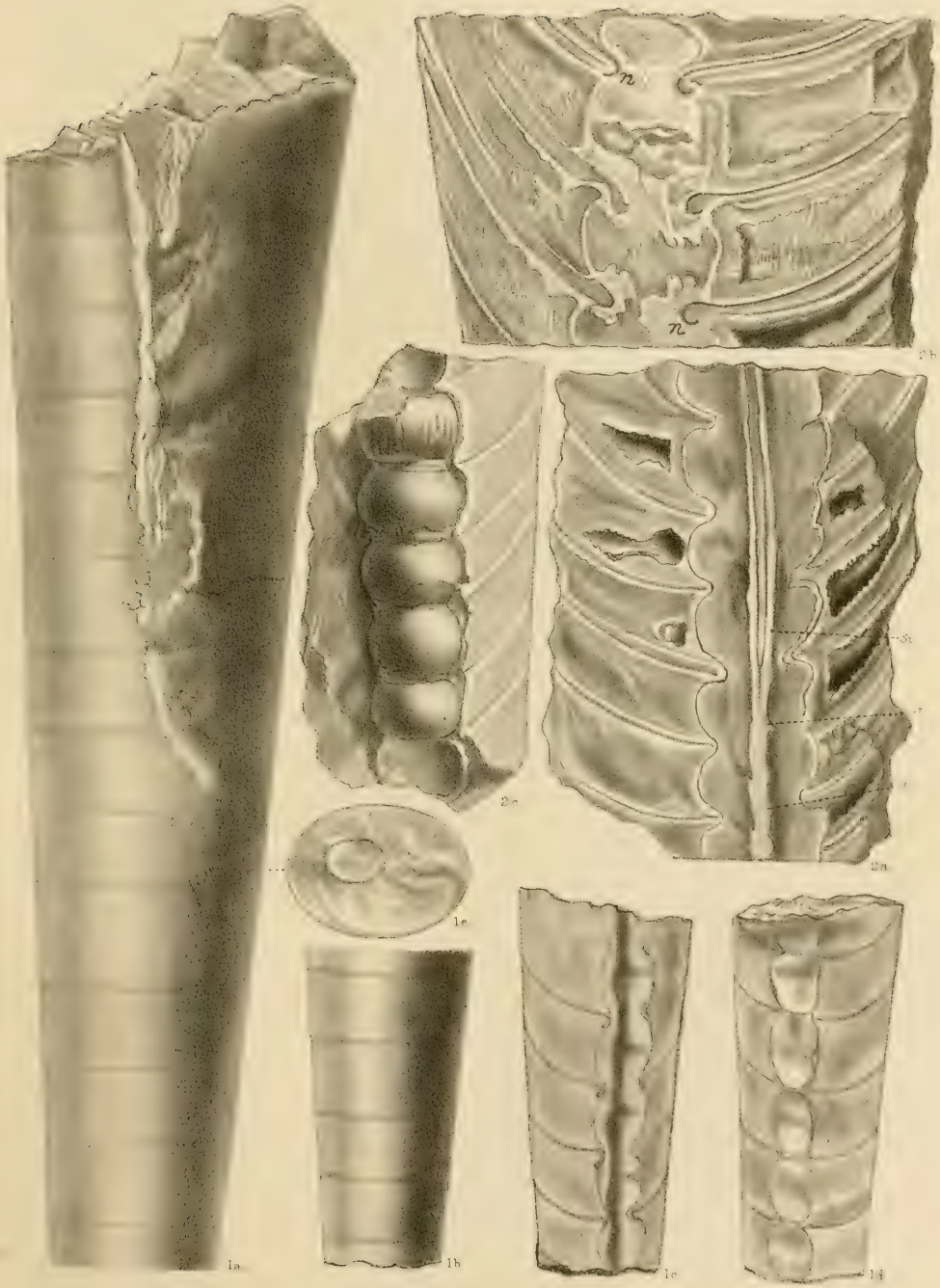
PLATE IX.

Actinoceras propinquum, sp. nov.

Figs. 1 *a*, 1 *b*. Fragment of the septate part of the shell, imperfect at both ends; the test has been removed and the under surface polished to show the septa; the apical part, 1 *c*, 1 *d*, is cut longitudinally to show the siphuncle and the endosiphuncle within. 1 *b* is separated from 1 *a* on the plate to enable the specimen to be figured without reducing its size. 1 *e*. Transverse section showing the siphuncle. Little Island. Dublin Museum of Science and Art. (Page 33.)

Actinoceras giganteum, *J. Sowerby*.

Fig. 2 *a*. Longitudinal section of a fragment, showing *si*, the endosiphuncle, with remains of the tubuli, *t*, *t*, given off from it. 2 *b*. Longitudinal section of another fragment, showing at *n*, *n*, the necks of the septa. No remains of the endosiphuncle are preserved in this specimen, which is filled with crystalline calcite. 2 *c*. Fragment with casts of the bulbous siphuncular segments; one of them shows the puckered appearance characteristic of their calcareo-membranous walls. Castle Espie. Museum of Trinity College, Dublin. (Page 28.)



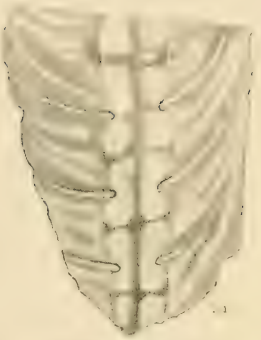
W.H. Crowther lith., A.H.F. dir.

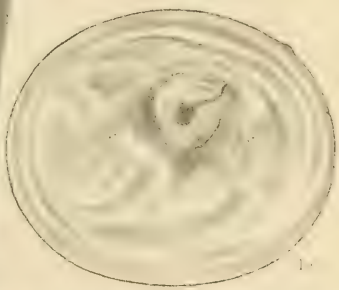
West, Newman imp.

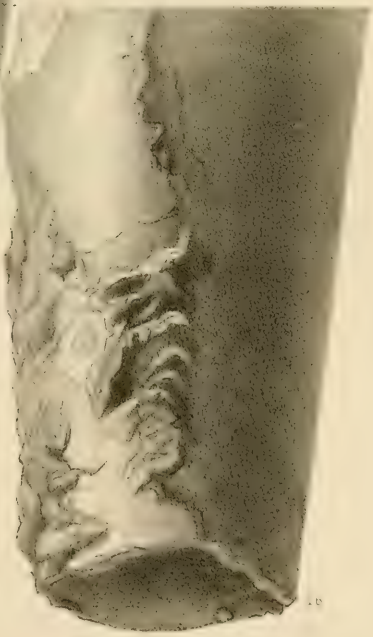
PLATE X.

ACTINOCERAS INSULARE, sp. nov.

Figs. 1 *a*, 1 *b*. Fragment of a portion of the septate part of a large specimen, showing the very oblique septation; a considerable part of the smooth test is present, so that the septa are not seen on the lower half of the specimen. 1 *c*. Transverse section showing the position of the siphuncle. 1 *d*. Longitudinal section showing siphuncle and endosiphuncle, with obscure remains of the tubuli attached to the latter. Little Island. Dublin Museum of Science and Art. (Page 30.)







W.H. Crowther lith., A.H.F. del. et dir.

West Newman imp.

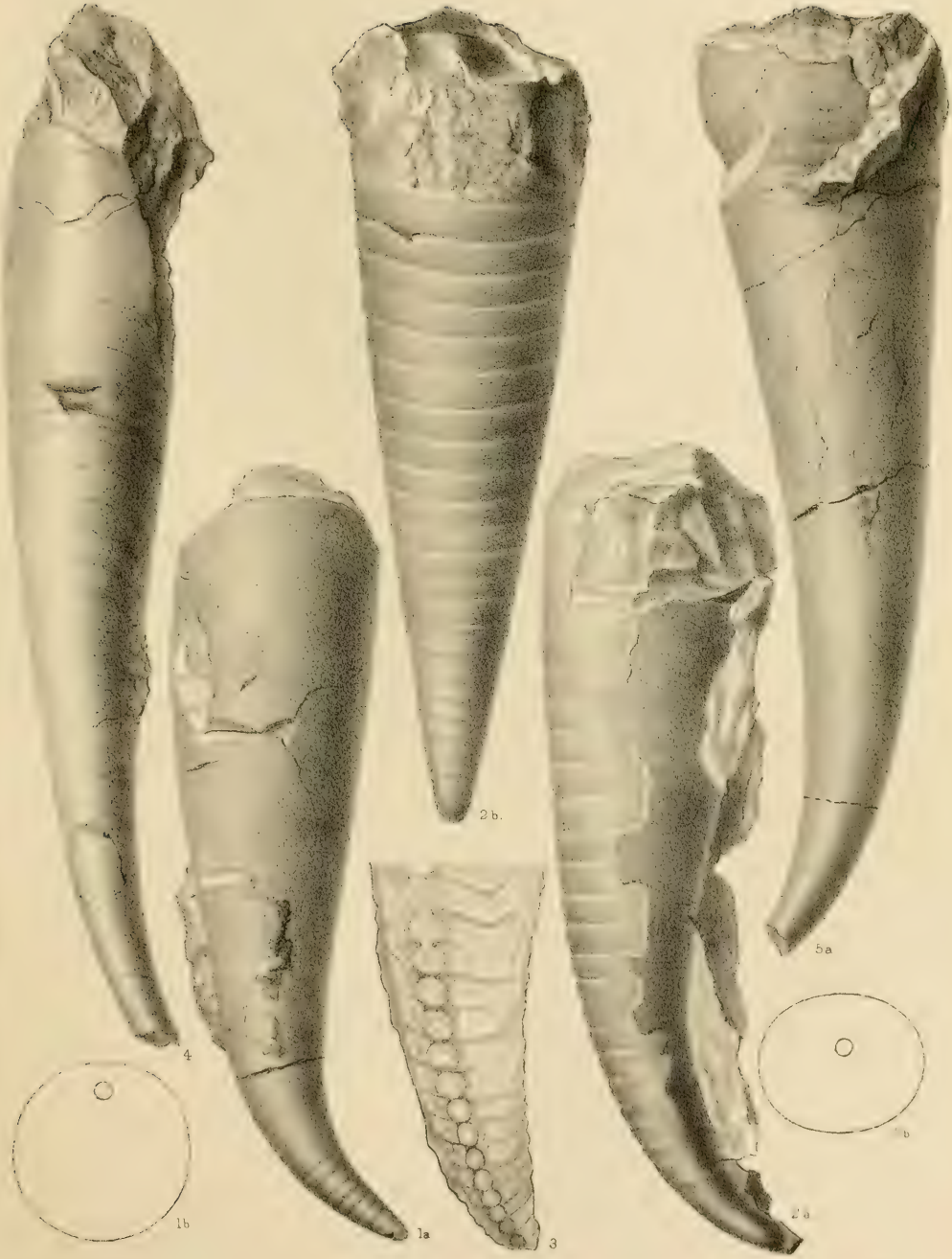
PLATE XI.

CYRTOCERAS (MELOCERAS) APICALE, sp. nov.

Fig. 1 *a*. A nearly perfect specimen covered with the test, but showing at the apex faint marks of the sutures. 1 *b*. Transverse section of the same. 2 *a*. Another specimen with only the septate part preserved. 2 *b*. Ventral view of the same, showing the horizontality of the sutures in this part of the shell. 3. Longitudinal section displaying the siphuncle and the septa, the latter displaced here and there. St. Doulagh's. Dublin Museum of Science and Art. (Page 33.)

CYRTOCERAS (MELOCERAS) ARCUATOSEPTATUM, sp. nov.

Fig. 4. A polished specimen showing the strongly arched sutures. 5 *a*. Another specimen with a portion of the body-chamber preserved. 5 *b*. Transverse section showing the position of the siphuncle. Little Island. Dublin Museum of Science and Art. (Page 37.)



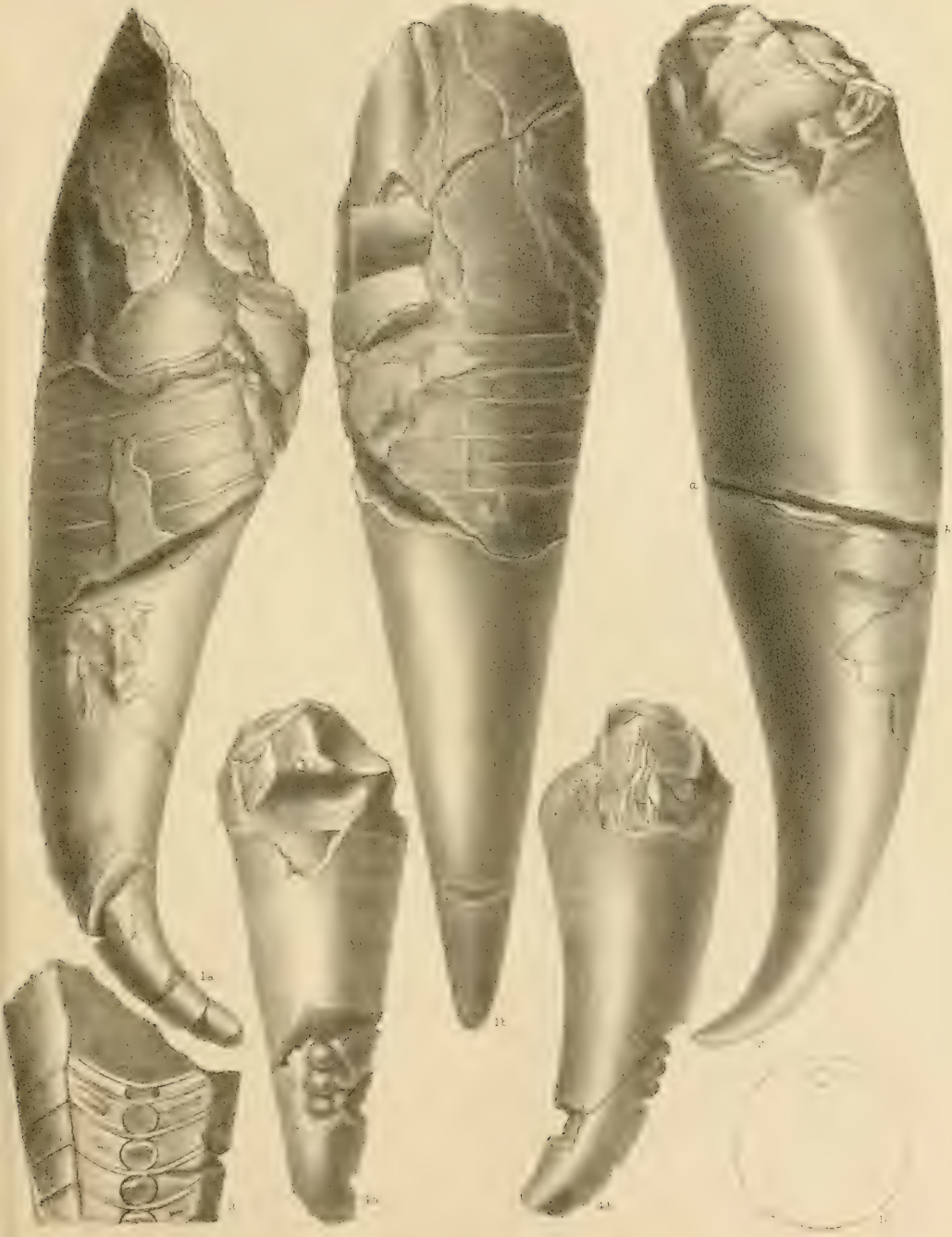
W.H.Crowther lith, A.H.F. dir.

West, Newman imp

PLATE XII.

CYRTOCERAS (MELOCERAS) APICALE, sp. nov.

Fig. 1 *a*. Lateral view of a specimen, nearly perfect at the apical end, showing part of the body-chamber and the obliquity of the sutures on the lateral areas. 1 *b*. Ventral view of the same specimen, showing the horizontality of the sutures on this aspect of the shell; the median line is also seen. 1 *c*. Transverse section showing the position of the siphuncle. 2. Lateral aspect of another specimen, perfect at the apex, but not preserved in such a way as to show any indication of a cicatrix; from *a* to *b* is the base of the body-chamber. 3. Polished longitudinal section of a portion of another specimen showing the siphuncle with its beaded segments. 4 *a*, 4 *b*. Ventral and lateral views respectively of a young individual, showing three of the beaded elements of the siphuncle. St. Doulagh's. Dublin Museum of Science and Art. (Page 33.)



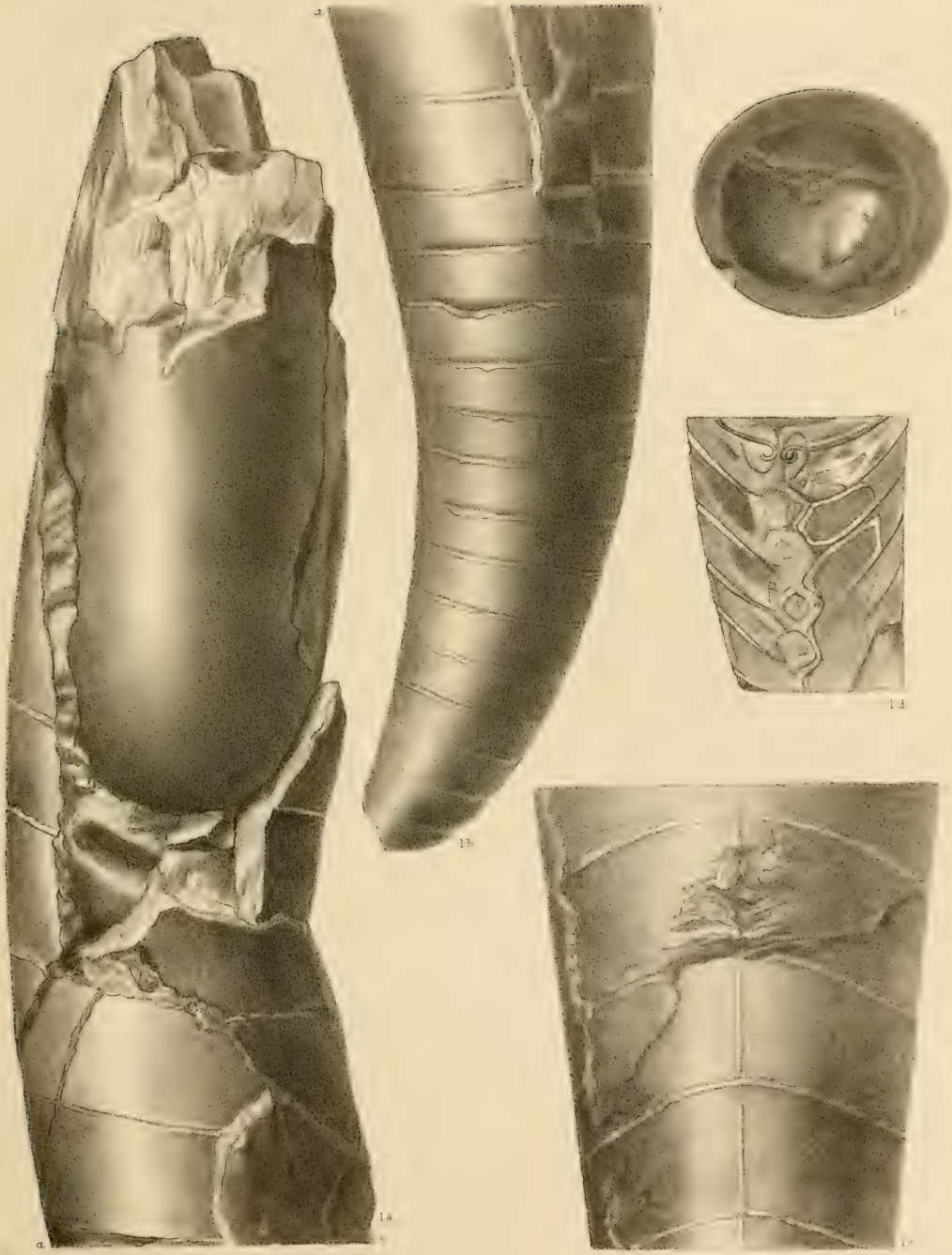
W.H. Crowther lith. A.H.F. dir.

West, Newman imp.

PLATE XIII.

EUSTHENOCERAS HULLI, *L. G. de Koninck*, sp.

Figs. 1 *a*, 1 *b*. A large specimen, imperfect at both ends, but with the greater part of the body-chamber preserved; the letters *a b*, *a b*, show where the two halves of the figures join. 1 *c*. Part of the same specimen, showing the arching of the sutures (in the anterior direction) and the distinct median or "normal" line. 1 *d*. Section taken from the apical part of the shell, showing the septa and their necks (upper part of the figure; but the necks are drawn with too narrow a space between them where the siphuncle would pass through). Obscure lines indicate where the siphuncle has been, but its form cannot be made out. 1 *e*. Transverse section, showing a little circle just above the centre which indicates the position of the siphuncle, but not quite so clearly in the specimen as in the drawing. Oldtown. Museum of Trinity College, Dublin. (Page 39.)



W.H. Crowther lith., A.H.F. del.

West, Newman imp.

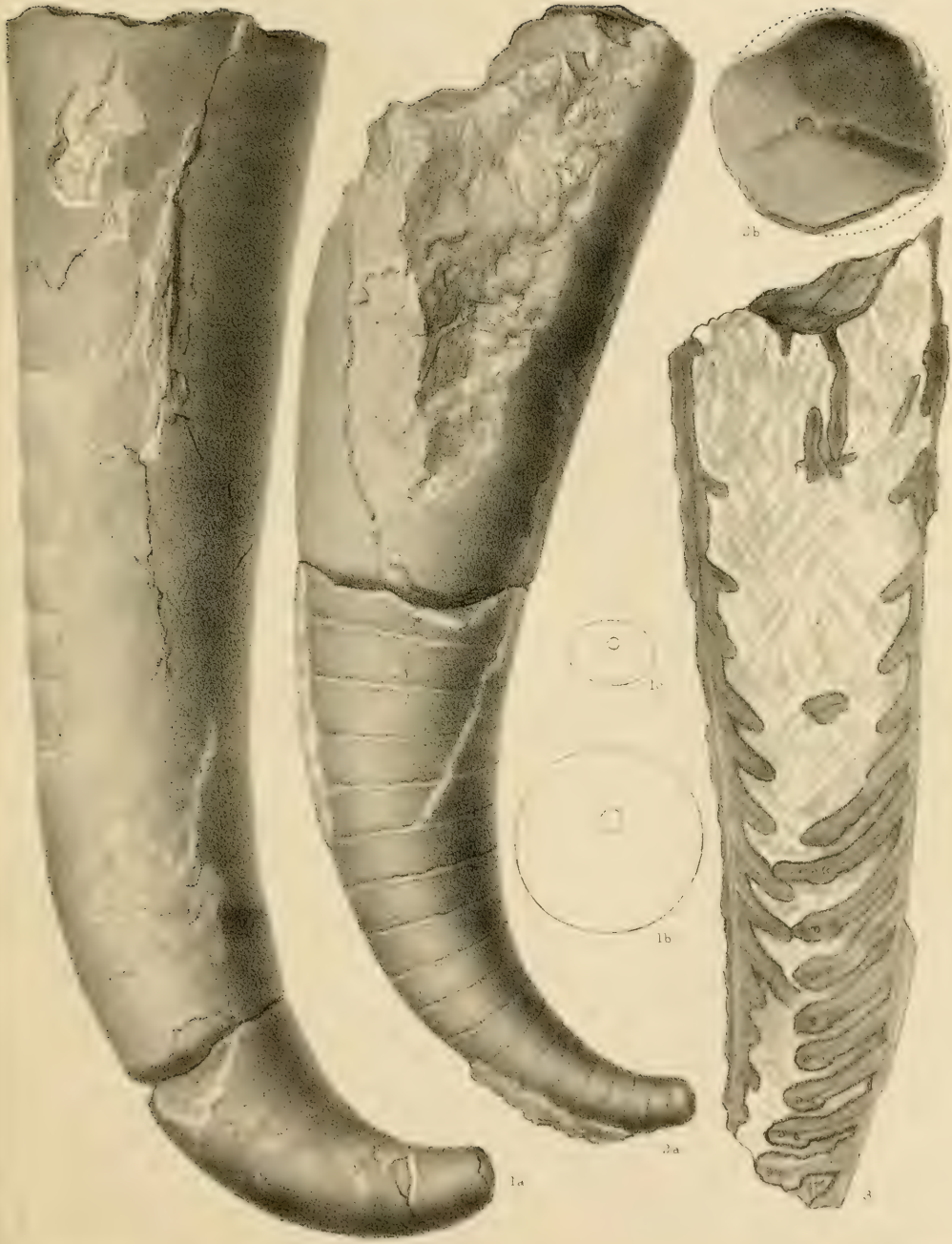
PLATE XIV.

EUSTHENOCERAS HULLI, *L. G. de Koninck*, sp.

Fig. 1 *a*. Lateral view of a specimen wanting the body-chamber and a small portion of the apical end; a short piece (about 15 mm.) of the upper end has been omitted, as it made the specimen too long for the plate. 1 *b*. The nearly circular transverse section showing the siphuncle. 1 *c*. Section at the apical end of an elliptical form. 3. Longitudinal section of another specimen of this species, showing the septa which have become coated over with a crystalline deposit of a fibrous nature; the necks of the septa are well preserved, but the siphuncle has become absorbed in the process of crystallisation; there are obscure remains of it in the upper part of the section, which seem to indicate that it was of cylindrical form, but this is by no means clear. The lighter tinted and white parts of the section represent crystalline calcite, which often fills these chambered shells to the destruction, partial or complete, of the internal parts. Rathkeale. Dublin Museum of Science and Art (Geological Survey of Ireland Collection). (Page 39.)

EUSTHENOCERAS BAILYI, *L. G. de Koninck*, sp.

Fig. 2 *a*. Lateral view of a nearly complete specimen (cast), showing the septa (sutures) and the greater part of the body-chamber; the extreme apex is broken off. 2 *b*. The last chamber viewed from above, showing the position of the siphuncle. Samphire Island. Dublin Museum of Science and Art (Geological Survey of Ireland Collection). (Page 42.)



A.H. Crowther lith., A.H.F. dir

West, Newman imp

PLATE XV.

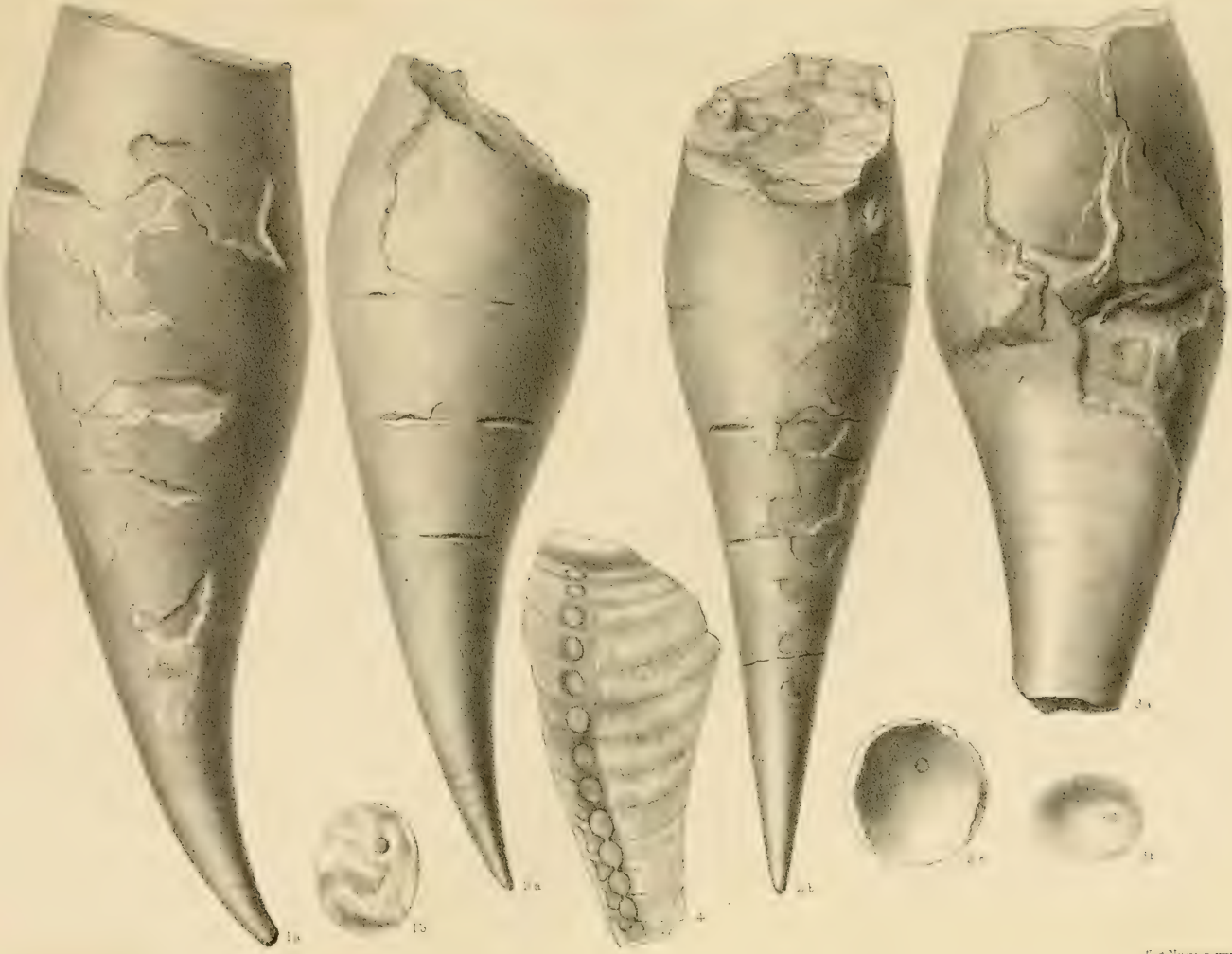
Poterioceras fusiforme, *J. de C. Sowerby*, sp.

Fig. 1 *a*. Imperfect specimen showing the septation on the ventral side, and the greater part of the body-chamber. 1 *b*. A septum of the same, showing the position of the siphuncle. 1 *c*. The same specimen viewed laterally, exhibiting the flattened ventral and inflated dorsal profiles. 2 *a*. Ventral view of another specimen, nearly perfect, the septate part almost covered by the test. The base of the body-chamber is seen along the line *a*, *b*, in 2 *b*, which is a lateral view of the same specimen. 2 *c*. A septum of the same, showing the siphuncle. The dotted line added to fig. 2 *c* enables it to be more readily compared with 2 *b*, which is placed for that purpose in the same position. 3. Posterior end of Sowerby's type specimen, contained in the British Museum. St. Doulagh's. Dublin Museum of Science and Art. (Page 43.)

PLATE XVI.

POTERIOCERAS LATISEPTATUM, sp. nov.

Fig. 1 *a*. A nearly perfect specimen wanting only a small portion of the apex. 1 *b*. Transverse section of the same showing the siphuncle. 2 *a*. Lateral view of another specimen. 2 *b*. Ventral view of the same. 2 *c*. Section of the same, showing the position of the siphuncle. 3 *a*. Lateral view of an imperfect specimen, showing the widely spaced septa. 3 *b*. Transverse section of the same, showing the position of the siphuncle. The elliptical form of the section is artificial, being due to the specimen having been ground and polished to show the sutures which were covered by the test. 4. Longitudinal section showing the siphuncle (this section was unfortunately not cut through the centre of the siphuncle, whose elements therefore appear oval and less than their full size would be). The last three chambers are extremely shallow. Clane. (Figs. 1, 3, and 4). County of Limerick (exact locality unknown—fig. 2). Dublin Museum of Science and Art. (Page 45.)



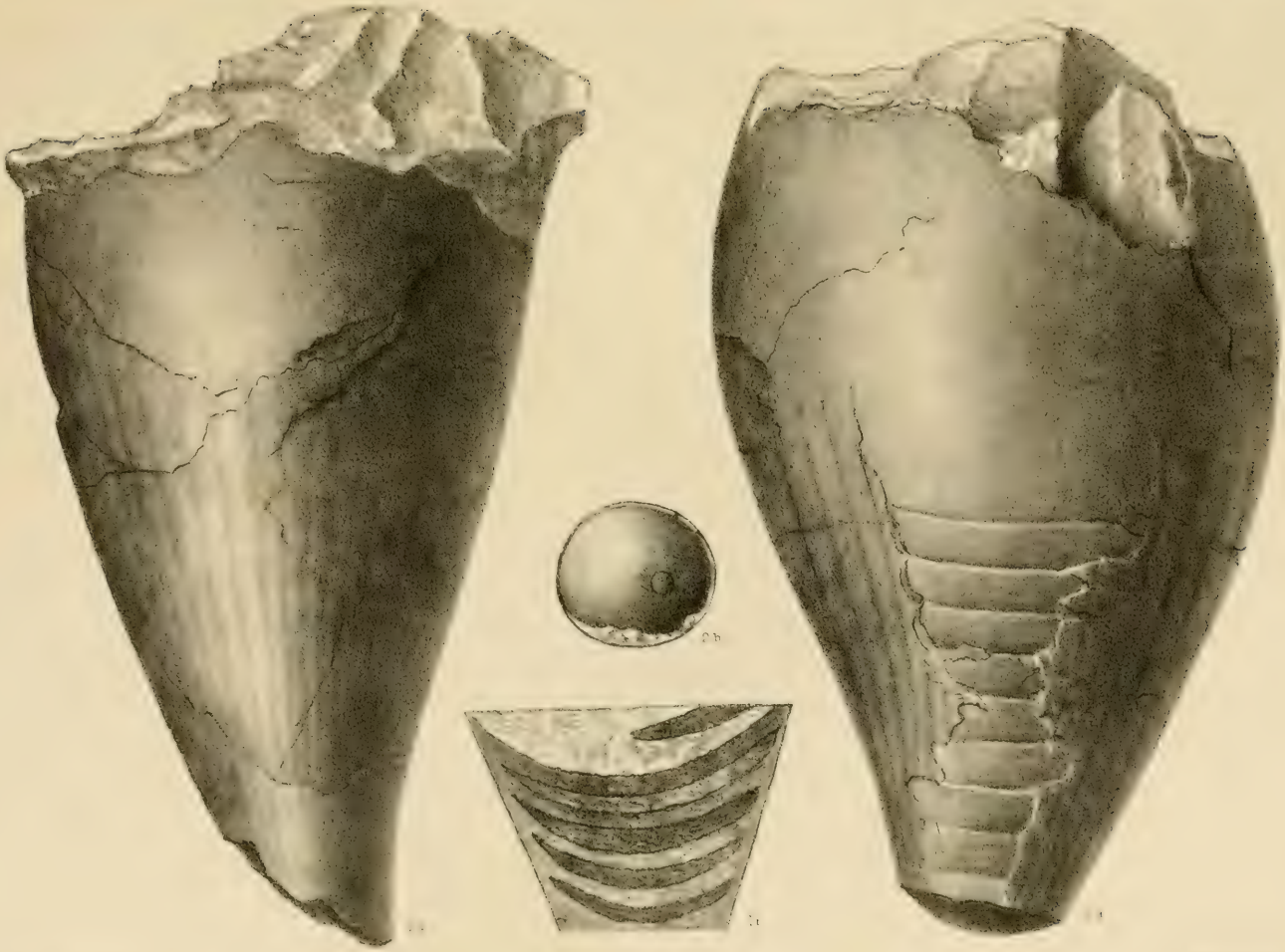
Wal Crowther lith. A.H.F. dir.

Dent, Newman imp.

PLATE XVII.

POTERIOCERAS VENTRICOSUM, *F. M'Coy.*

Fig. 1 *a*. Lateral view of an imperfect specimen, showing the faint longitudinal ridges. 1 *b*. Longitudinal section showing the septa (dark-tinted spaces) much thickened and obscured by crystalline deposits. 2 *a*. A fine specimen showing the septa and the greater part of the body-chamber. 2 *b*. Transverse section of the same, showing the position of the siphuncle. Clane. Dublin Museum of Science and Art. (Page 46.)



W.H. Crowther lith. A.H.F. del.

West, Newman imp.

PLATE XVIII.[1]

Temnocheilus coronatus, *F. M'Coy*.

Fig. 1 *a*. Lateral view of the much-distorted type specimen figured by M'Coy ('Synop. Carb. Foss. Ireland,' pl. iv, fig. 15). 1 *b*. Front view of the same, the siphuncle obscurely seen above the centre of the septum. Little Island, Cork. Dublin Museum of Science and Art ("Griffith Collection"). (Page 49.)

Fig. 2 *a*. Lateral view of the inner whorls of a fine specimen collected by Mr. E. J. Garwood, F.G.S., at Stebden Hill, near Cracoe, Yorkshire. The specimen is now in the British Museum, and is here re-figured for comparison with M'Coy's specimen, which still remains unique in Ireland. (Page 49.)

Trigonoceras paradoxicum, *J. de C. Sowerby*, sp.

Fig. 3 *a*. Lateral view of a specimen covered with the test, and showing the fine ridge near the peripheral border. 3 *b*. Longitudinal section of the posterior portion of the same, showing the septa and siphuncle which have been displaced and distorted by crystallisation. The darkly shaded part above is the lower portion of the body-chamber. 3 *c*. Diagrammatic cross-section of 3 *a*. Clane. Dublin Museum of Science and Art. (Page 51.)

Fig. 4 *a*. Dorsal or antiperipheral view of another specimen, showing the prominent longitudinal keel and the faint ridges on each side of it. 4 *b*. Peripheral view of the same, showing strong marginal keels and the septa very faintly discernible. Kildare (probably Clane). British Museum. (Page 51.)

Fig. 5. Outline of colour-bands on a specimen from Clane, in the Public Museum, Belfast. The vertical line indicates the dorsal keel. (Page 51.)

[1] The figures in this and the following Plates represent the specimens of the natural size unless the contrary is stated.

[illegible] Brock del
W.H. Crowther lith.

West Newman imp.

PLATE XIX.

Cœlonautilus planotergatus, *F. M'Coy*, sp.

Fig. 1 *a*. Lateral view of the distorted and imperfect specimen figured by M'Coy in the 'Synopsis' (pl. ii, fig. 2). 1 *b*. Peripheral view of the same, showing the sutures of the septa. Cork (near the city). Dublin Museum of Science and Art ("Griffith Collection"). (Page 53.)

Fig. 2 *a*. Part of inner whorl of another specimen, showing sutures of the septa. 2 *b*. Part of penultimate whorl of the same, showing the impressed zone, with the mark of the sutures of the inner whorl, which it overlaps. 2 *c*. Diagrammatic section showing the position of the siphuncle. Rathkeale. Dublin Museum of Science and Art (Geological Survey Collection). (Page 53.)

Cœlonautilus Doohylensis, sp. nov.

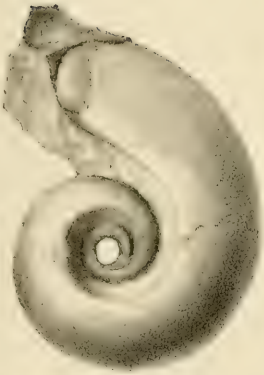
Fig. 3 *a*. Lateral view of an imperfect specimen. 3 *b*. Peripheral view of the same, showing the fine ridges. 4 *a*. View of the septal surface of another individual, showing the position of the siphuncle. 4 *b*. Profile view of the same. Doohyle. Dublin Museum of Science and Art. (Page 56.)

Planetoceras globatum, *J. de C. Sowerby*, sp.

Fig. 5 *a*. Lateral view of an adult individual. 5 *b*. Front aspect of the same. About three-fourths of the natural size. "Kildare" (probably Clane). British Museum. (Page 96.)

Fig. 6. Lateral view of a young and perfect individual. St. Doulagh's. My Collection. (Page 96.)

5a



5

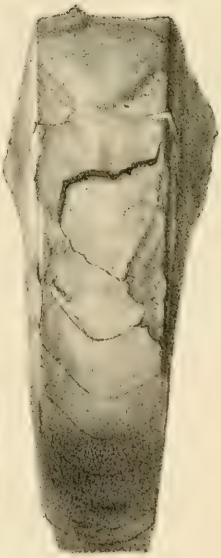
5b

4b

4a

3a

3

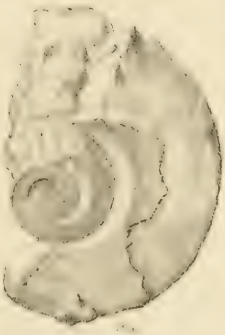


3b

1a

2

1



1b

PLATE XX.

Cœlonautilus gradus, *A. H. Foord.*

Fig. 1 *a*. Lateral aspect of an adult and nearly perfect individual, showing the faint folds on the sides of the inner whorls. 1 *b*. Part of the periphery of another specimen, showing the longitudinal ridges. Kildare. British Museum. (Page 57.)

Fig. 2. Polished section of another individual, showing the septa and siphuncle, and almost the whole of the body-chamber. Kildare. British Museum. (Page 57.)

Fig. 3. Peripheral view of an individual in which strong nodular folds are developed as well as ridges; the edge of the aperture is seen. Curraghbridge. Dublin Museum of Science and Art (Geological Survey Collection). (Page 57.)

Fig. 4. View of the inner whorls of another individual, showing their quadrate form and the position of the siphuncle. Rathkeale. Dublin Museum of Science and Art (Geological Survey Collection). (Page 57.)

The following are considered to be the young of this species; they are all from Rathkeale and are contained in the Dublin Museum of Science and Art.

Fig. 5. Lateral aspect of a specimen, showing the slight folds on the inner whorls (cf. Fig. 1 *a*). (Page 57.)

Fig. 6. Peripheral view of a specimen, showing the outline of the aperture, and some of the fine and sharp longitudinal ridges. (Page 57.)

Fig. 7 *a*. Lateral view of a specimen, showing the sutures of the septa. 7 *b*. Front view of the same individual. (Page 57.)

Fig. 8 *a*. Lateral aspect of a specimen, showing the minute crenulations on the peripheral and umbilical edges (the drawing necessarily makes them appear coarser than they are in nature). 8 *b*. Part of the peripheral area of the same individual, showing the fine longitudinal ridges, and the sinuous lines which indicate the position of former apertures of the shell. (Page 57.)

Fig. 9 *a*. Part of the outer and inner whorls of a specimen, showing their quadrate form and the position of the siphuncle. 9 *b*. Part of the inner whorls of the same individual, the smaller showing, with the aid of a lens, fine longitudinal lines (indicated in the figure), as well as minute transverse lines too fine to be represented. (Page 57.)

Stroboceras sulcatum, *J. de C. Sowerby*, sp.

Fig. 10 *a*. Lateral aspect of a specimen, showing the ornamentation. 10 *b*. Peripheral view of the same. Little Island, near Cork. Dublin Museum of Science and Art. (Page 60.)

Fig. 11. Lateral view of a distorted but well-preserved individual, showing the apical point and ornamentation. Little Island, near Cork. Dublin Museum of Science and Art. (Page 60.)

Fig. 12. Lateral aspect of a very imperfect specimen, showing the septa. Mullaghfarry, Killala. Dublin Museum of Science and Art ("Griffith Collection"). (Page 60.)

Stroboceras crassum, sp. nov.

Fig. 13 *a*. Lateral view of a fragment of the body-chamber, showing the ridges and sulci. 13 *b*. View of the periphery of the same, showing the superiority of its breadth to that of *Stroboceras sulcatum*. 13 *c*. Transverse section of the same in outline. Ring, near Enniskillen. Dublin Museum of Science and Art ("Griffith Collection"). (Page 64.)

Mesochasmoceras latidorsatum, *F. M'Coy*, sp.

Fig. 14 *a*. Lateral view of a nearly perfect specimen. 14 *b*. Portion of the same, showing the sutures of the septa. Argoul South. Dublin Museum of Science and Art (Geological Survey Collection). (Page 73.)

Fig. 15 *a*. Another specimen, imperfect at both extremities. 15 *b*. View of the periphery of the same, showing the fine ridges near its margins. 15 *c*. Body-chamber (fragment) of the same, detached from the septate part of the shell, showing the zone of impression and the form of the whorls as seen in transverse section. 15 *d*. Another piece of the same specimen, showing part of the innermost whorl and the position of the siphuncle. Cragard. Dublin Museum of Science and Art (Geological Survey Collection). (Page 73.)

West, Newman lith.

PLATE XXI.

Apheleceras mutabile, *F. M'Coy*, sp.

Fig. 1 *a*. Lateral view of an imperfect specimen. 1 *b*. Peripheral view of the same, showing the lines of growth. Somewhat reduced in size. Kildare (probably Clane). British Museum (No. C. 134). (Page 65.)

Fig. 2 *a*. Transverse section of whorl of another specimen, showing position of siphuncle. 2 *b*. Part of inner whorl of the same, showing fine longitudinal lines. 2 *c*. Part of initial whorl of the same. Clane. Dublin Museum of Science and Art. (Page 65.)

Fig. 3. Polished section, showing the septa and siphuncle. Clane. Dublin Museum of Science and Art. (Page 65.)

Apheleceras hibernicum, *A. H. Foord and G. C. Crick*, sp.

Fig. 4 *a*. Lateral aspect of a nearly perfect specimen (figured 'Geological Magazine,' loc. cit.). 4 *b*. Peripheral aspect of the same. 4 *c*, 4 *d*. Details of the ornamentation somewhat enlarged: 4 *c*, that of the periphery; 4 *d*, that of part of the inner whorl at the bend near the apex. St. Doulagh's. British Museum. (Page 68.)

Fig. 5. Lateral view of a nearly perfect specimen, with the ornamentation completely preserved. St. Doulagh's. Dublin Museum of Science and Art. (Page 68.)

Fig. 6. Fragment of another individual, polished to show the septation. St. Doulagh's. Dublin Museum of Science and Art. (Page 68.)

Fig. 7 *a*. Fragment of the body-chamber of a large individual, with a considerable part of the test, well preserved and showing fine lines of growth, which become coarser near the aperture (top of figure). 7 *b*. Lower extremity of the same, showing the position of the siphuncle. St. Doulagh's. British Museum. (Page 68.)

Vestinautilus cariniferus, *J. de C. Sowerby*, sp.; var. magnicameratus, var. nov.

Fig. 8. Peripheral view of a distorted specimen, showing the wide septation (cf. Plate XXIII, fig. 2). Limerick (exact locality unknown, probably near the city). Dublin Museum of Science and Art. (Page 84.)

PLATE XXII.

Triboloceras formosum, sp. nov.

Fig. 1. Lateral view of a large imperfect specimen, showing the prominent, spiral, crenulated ridges. Lisbane. Dublin Museum of Science and Art (Geological Survey Collection). (Page 75.)

Fig. 2. Peripheral view of a young individual, showing the strong ridges and deep furrows. Garrihies (Kerry). Dublin Museum of Science and Art (Geological Survey Collection). (Page 75.)

Vestinautilus semiglaber, sp. nov.

Fig. 3. Lateral view of an adult (?) individual with most of the body-chamber present, and showing the highly crenulated lateral ridges and the smooth area facing the umbilicus. Lisbane. Dublin Museum of Science and Art (Geological Survey Collection). (Page 78.)

Fig. 4 *a*. Lateral view of a younger individual, showing (too indistinctly in the figure) the septa on the inner whorls. (The outline of this figure is a little distorted; this is erroneous, as the specimen is perfectly symmetrical.) 4 *b*. Peripheral view of the same, showing rather faint ridges. 4 *c*. Transverse section (diagrammatic—the two oblique lines at the lower part of the figure representing the smooth area are made a little too short). Lisbane. Dublin Museum of Science and Art (Geological Survey Collection). (Page 78.)

Vestinautilus crassimarginatus, sp. nov.

Fig. 5 *a*. Lateral view of a large and nearly perfect individual, showing the heavy rim bordering the umbilicus and the fine and regular lines of growth covering the test. 5 *b*. Front view of the same. (Note the curvature of the lines of growth in crossing the periphery.) 5 *c*. Diagrammatic transverse section, showing the position of the siphuncle. Little Island. Dublin Museum of Science and Art. (Page 79.)

PLATE XXIII.

VESTINAUTILUS CARINIFERUS, *J. de C. Sowerby*, sp.

Fig. 1 *a*. Lateral view of a perfect specimen, showing the strong keel bordering the umbilicus, hidden in the inner whorls. 1 *b*. Front view of the same, showing faint ridges which divide the periphery longitudinally into three distinct areas. Clane. Dublin Museum of Science and Art. (Page 82.)

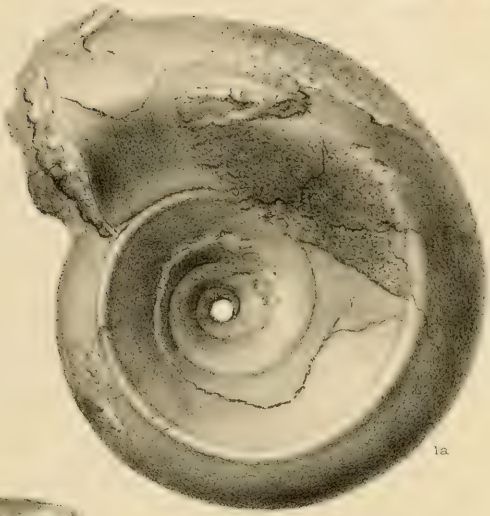
Fig. 2. Lateral view of a specimen showing the septation, some of the test still adhering to the cast. St. Doulagh's. Dublin Museum of Science and Art. (Page 82.)

Fig. 3. Front view of a young specimen with remarkably strong peripheral keels. Ardtomin, county of Limerick. Dublin Museum of Science and Art (Geological Survey Collection). (Page 82.)

VESTINAUTILUS CRATERIFORMIS, sp. nov.

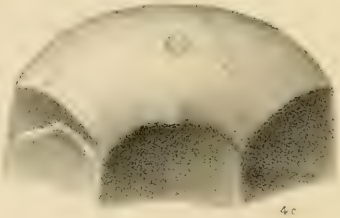
Fig. 4 *a*. Lateral view, showing septate part and most of the body-chamber; some of the test remains. 4 *b*. Front view, showing the arched conformation of the sutures in crossing the periphery. 4 *c*. View of the base of the body-chamber, showing the position of the siphuncle, also the annular or dorsal lobe of the sutures. Glenbane West, county of Limerick. Dublin Museum of Science and Art (Geological Survey Collection). (Page 85.)

1b


1a

3

2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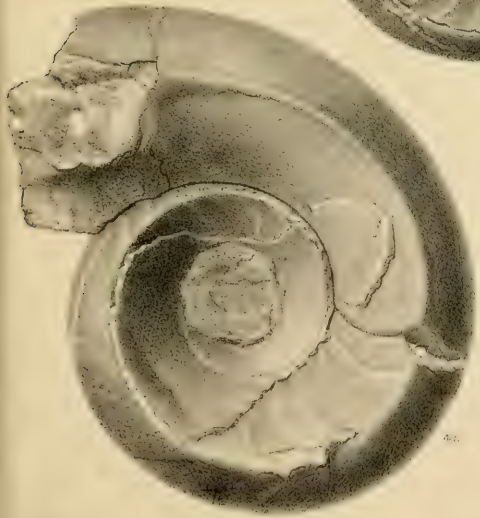
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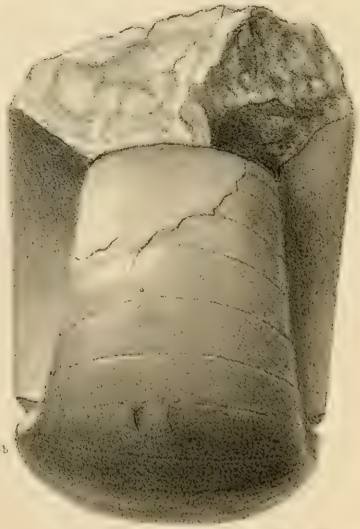

4b

T.A.Brock del.
W.H.Crowther lith.

PLATE XXIV.

VESTINAUTILUS PAUCICARINATUS, *A. H. Foord*, sp.

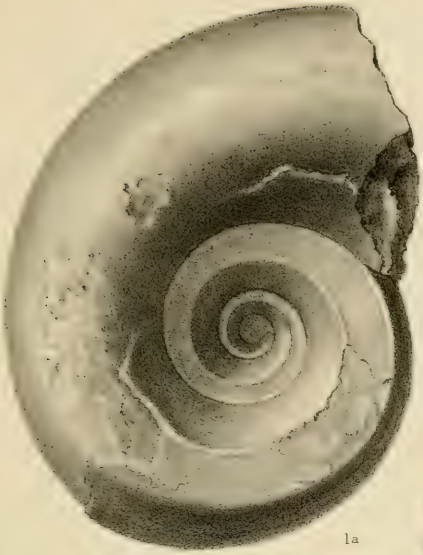
Fig. 1 *a*. Lateral view of a nearly perfect specimen, showing the characteristic inner keel of this species 1 *b*. Front view, showing the peripheral keels. Ireland (exact locality unknown). British Museum. (Page 86.)

Fig. 2. Front view of a large specimen, showing the close septation upon the peripheral area. Glenbane West, county of Limerick. Dublin Museum of Science and Art (Geological Survey of Ireland). (Page 86.)

Fig. 3. Polished section of an individual, showing the septa and siphuncle and the greater part of the body-chamber. St. Doulagh's. My Collection. (Page 86.)

Fig. 4. Lateral view of a young individual St. Doulagh's. Dublin Museum of Science and Art. (Page 86.)

Fig. 5. Ornamentation of the test of another specimen, enlarged; this is rarely preserved. (The lines in this figure are proportionally too fine; they are also too irregular.) St. Doulagh's. Dublin Museum of Science and Art. (Page 86.)



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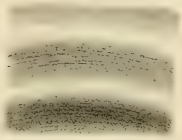

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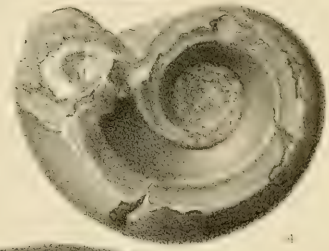


4

2

T.A.Brock del.
W.H.Crowther lith.

West, Newman imp.

PLATE XXV.

Vestinautilus semiplicatus, sp. nov.

Fig. 1 *a*. Lateral view of a nearly perfect specimen, showing the cast of the body-chamber, the test having been mostly stripped off. 1 *b*. View of the periphery of the same, showing the tubercles and the strong fold; the outline of the aperture is seen above. Rathkeale. Dublin Museum of Science and Art. (Page 91.)

Fig. 2 *a*. Lateral view of supposed young individual of the same species. 2 *b*. Peripheral view of the same, showing very strong keels. Rathkeale. Dublin Museum of Science and Art (Geological Survey Collection). (Page 91.)

Vestinautilus pinguis, *L. G. de Koninck*, sp.

Fig. 3 *a*. Lateral aspect of the septate part of a well-preserved individual. 3 *b*. Peripheral view of the same, showing faint ridges on the cast. Limerick (probably near the city). Dublin Museum of Science and Art. (Page 89.)

Vestinautilus multicarinatus, *J. de C. Sowerby*, sp.

Fig. 4 *a*. Lateral aspect of an imperfect specimen. 4 *b*. Peripheral aspect of the same, showing the numerous keels. Ireland (exact locality unknown). British Museum (No. 50,192). (Page 93.)

Fig. 5. Fragment showing the apical part of the initial whorl. Ireland (exact locality unknown). Museum of Trinity College, Dublin. (Page 93.)

T.A.L. ockdel.
W.H.Crowther lith.

West, Newman imp.

PLATE XXVI.

Thrincoceras Hyatti, sp. nov.

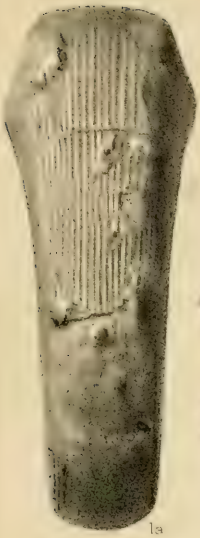
Fig. 1 *a*. Peripheral view of a specimen. 1 *b*. Lateral view of the same, showing the fine ridges covering the whole of the shell. 1 *c*. Part of another specimen, showing the impressed zone, also ridged. 1 *d*. Ornamentation (from 1 *b*, the side of the shell) enlarged about twelve times. 1 *e*. The same slightly enlarged. 1 *f*. The same in the very young shell. 1 *g*. Septum of another specimen, showing position of siphuncle. St. Doulagh's. Museum of the Royal College of Science for Ireland, Dublin, except 1 *g*. (Page 98.)

Thrincoceras hibernicum, *A. H. Foord*, sp.

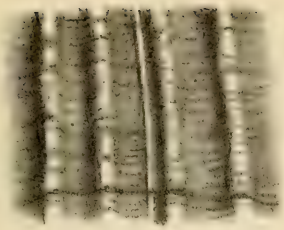
Fig. 2 *a*. Lateral aspect of an imperfect specimen, showing the septa of the inner whorls. 2 *b*. Peripheral view of the same, showing the lines of growth crossing it in a sinuous manner. Glenbane. Dublin Museum of Science and Art (Geological Survey Collection). (Page 101.)

Discitoceras Wrightii, sp. nov.

Fig. 3 *a*. Lateral view of an imperfect but undistorted specimen, showing the ornamentation. Midleton. Dublin Museum of Science and Art. 3 *b*. Lateral view of a distorted specimen, showing some of the coarser lines of growth. 3 *c*. Section, transversely to the whorls, of another specimen, showing the position of the siphuncle. 3 *d*. Bead-like ornamentation taken from 3 *a*. Little Island. Dublin Museum of Science and Art. (Page 105.)



1a



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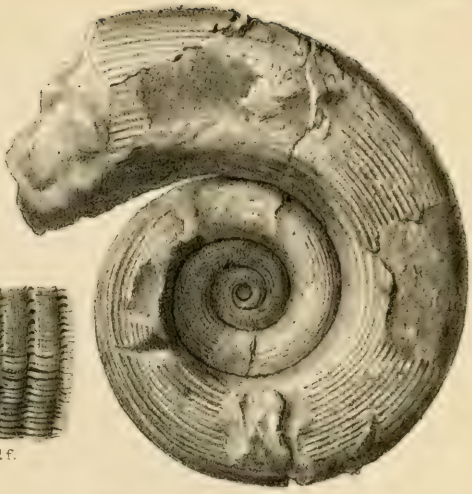
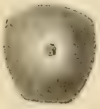


1b

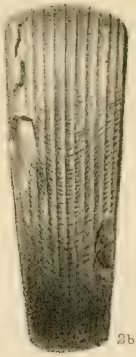
1e



1g

1f

2a



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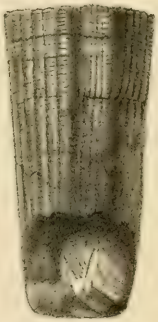

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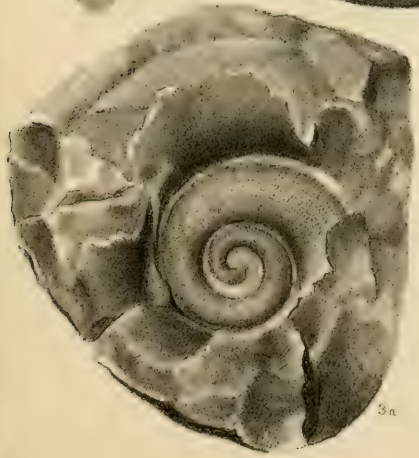


3a

3d

3c

West, Newman lith.

PLATE XXVII.

Discitoceras Leveilleanum, *L. G. de Koninck*, sp.

Fig. 1 *a*. Lateral view of a young and perfect individual, somewhat distorted; the margin of the aperture is seen, and the lines of growth near it are very distinct. (The light spots near the margin of the whorl, above the break in the shell, are of no significance.) 1 *b*. Front view of the same specimen. Clane. Dublin Museum of Science and Art. (Page 102.)

Fig. 2 *a*. Lateral view of a remarkably fine and perfect individual, slightly distorted; the figure shows well the fine and regular lines of growth, and the fine longitudinal ridges extending to the beginning of the last whorl. 2 *b*. Peripheral view of the same specimen, showing the deep sinus in the margin of the aperture. 2 *c*. Ornamentation of the penultimate whorl enlarged. Clane. Dublin Museum of Science and Art. (Page 102.)

Fig. 3. Lateral view of an undistorted specimen, showing part of the septation and the whole of the body-chamber. Ballyhomon. Dublin Museum of Science and Art (Geological Survey Collection). (Page 102.)

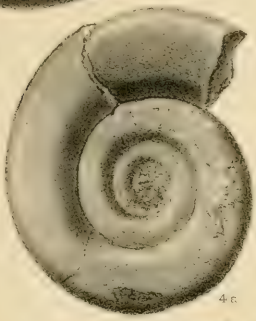
? Discitoceras discors, *F. M'Coy*, sp.

Fig. 4 *a*. Lateral view of a specimen wanting a considerable part of the body-chamber; its base is where the fracture is shown. 4 *b*. Front view of the same. 4 *c*. Part of the last whorl of the same specimen extending to the base of the body-chamber, showing the zone of impression and the position of the siphuncle. (These figures are reduced to about two-thirds of the natural size.) 4 *d*. View of a septum (natural size), showing the position of the siphuncle and the annular lobe. 4 *e*. Profile view of the same. Ballygarrane. Dublin Museum of Science and Art. (Page 104.)

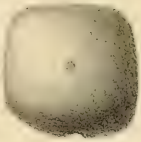
1a

2a

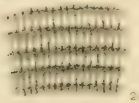
4b


4c

4e


4d

4r


2

3

1b

2b

T.A.Brock del
W.H.Crowther lith

West, Newman imp

PLATE XXVIII.

ACANTHONAUTILUS BISPINOSUS, *A. H. Foord.*

Fig. 1. Front view of the only individual yet found, showing the spine on the right-hand side; the shaded one on the other side is a "restoration," put in merely to balance the figure. The sutures of the septa are seen on the right-hand side of the figure (see also Pl. XXIX). Clane. Dublin Museum of Science and Art. (Page 118.)

VESTINAUTILUS CARINIFERUS, *J. de C. Sowerby*, sp.; var. TRIPLICATUS, var. nov.

Fig. 2 *a*. Lateral view of the only specimen collected, showing upon the test near the aperture two strong plications, with part of a third, the latter almost entirely removed with the test of which it formed part. 2 *b*. Peripheral view of the same individual, showing the "Runzelschicht," and the fine, somewhat regular lines of growth. The plications are shown on the left-hand side of the figure. The emargination above represents the sinus in the aperture. (Owing partly to the way in which the specimen was drawn with reference to illumination these plications are not represented as they appear in the fossil. There is a boldness of contour in the centre and more projecting one, which the drawing quite fails to convey any idea of; it is much too soft in outline in the figure [2 *a*]. In fig. 2 *b* the plications are still more feebly rendered.) Glenbane. Dublin Museum of Science and Art (Geological Survey Collection). (Page 112.)

PHACOCERAS OXYSTOMUM, *J. Phillips*, sp.

Fig. 3 *a*. Lateral view of an imperfect specimen, showing part of the inner whorls and the septation, with the greater portion of the body-chamber. 3 *b*. Front view of the same, showing the knife-like periphery. Locality unknown. British Museum ("Gilbertson Collection"). (Page 108.)

DISCITOCERAS COSTELLATUM, *F. M'Coy*, sp.

Fig. 4 *a*. Lateral view of an imperfect specimen, which is probably part of the one figured by M'Coy ('Synopsis,' pl. ii, fig. 4). 4 *b*. Peripheral view of the same. Millicent, Clane. Dublin Museum of Science and Art ("Griffith Collection"). (Page 107.)

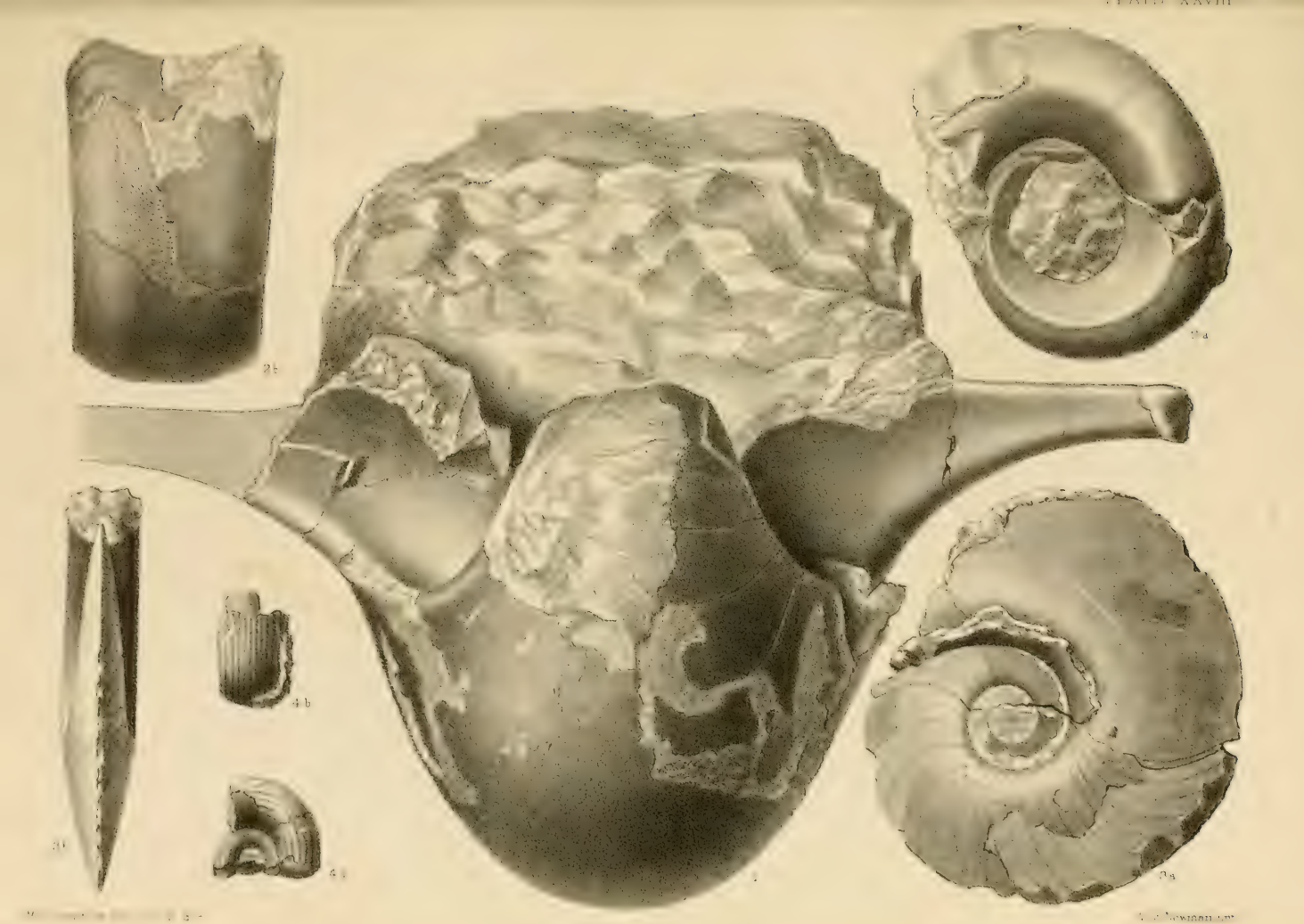


PLATE XXIX.

ACANTHONAUTILUS BISPINOSUS, *A. H. Foord*.

Fig. 1. Lateral view of the same individual as that figured on Pl. XXVIII, showing the umbilical cavity with its thick rim and the broken stump of the spine. (Page 118.)

PHACOCERAS ? RECTISUTURALE, sp. nov.

Fig. 2 *a*. Lateral view (cast) of the only individual known, showing the remarkably straight sutures and part of the body-chamber. 2 *b*. Peripheral view. 2 *c*. Front view, showing the angular border and steep walls of the umbilicus County of Kildare (?). Public Museum, Belfast. (Page 111.)

W.H.Crowther lith
A.H.F. Rose del. et delin. nat

PLATE XXX.

Aipoceras compressum, *A. H. Foord.*

Fig. 1 *a*. Lateral view of a specimen wanting only a portion of the body-chamber; the flattened dorsal area and the sutures are well shown. 1 *b*. Front view of the same. Clane. Dublin Museum of Science and Art. (Page 116.)

Coloceras bistriale, *J. Phillips*, sp.

Fig. 2 *a*. Lateral view of a well-preserved specimen, showing the two fine ridges that encircle the inner whorls close to the umbilical border. 2 *b*. Front view of the same individual, showing the broad peripheral area. 2 *c*. Peripheral view of the same, exhibiting on the cast of the body-chamber a sharply defined impression of a former edge of the aperture, with the hyponomic sinus. Tomdeely South, county of Limerick. Dublin Museum of Science and Art (Geological Survey Collection). (Page 115.)

Coloceras Coyanum, *A. d'Orbigny*, sp.

Fig. 3. Lateral view of the type specimen figured by M'Coy under the name of *Temnocheilus pinguis* ('Synopsis,' pl. iv, fig. 12, which is a reversed view of the fossil; it is represented correctly in my figure). Kilmallock, county of Limerick. Dublin Museum of Science and Art ("Griffith Collection"). (Page 113.)

Acanthonautilus bispinosus, *A. H. Foord.*

Fig. 4 *a*. Upper edge of spine drawn to show its thickness or smaller diameter; the left of the figure is the proximal end. 4 *b*. Proximal end where broken off from the shell, designed to show the two diameters of the spine. (The projection below, at right-hand side of figure, is merely matrix.) 4 *c*. Distal extremity. (Page 118.)

J. A. Brook del.
W.H. Crowther lith.

PLATE XXXI.

ASYMPTOCERAS CRASSILABRUM, sp. nov.

Fig. 1. Lateral view of a nearly perfect though somewhat distorted individual.

Fig. 2. Front view of a slightly distorted individual in which the thickened lip is well developed.

Both specimens from Clane. Dublin Museum of Science and Art. (Page 122.)

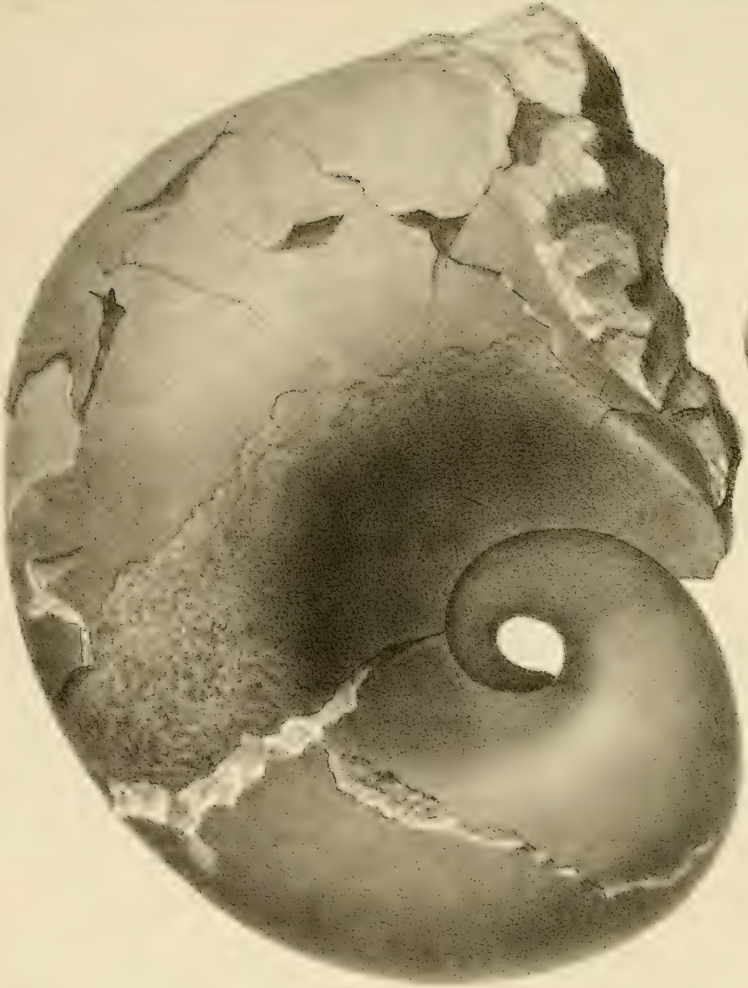


PLATE XXXII.

Asymptoceras Foordi, *A. Hyatt.*

Fig. 1 *a*. Lateral view of a somewhat distorted specimen, showing the inflation of the inferior border of the aperture, and the septation. 1 *b*. Front view of the same, showing the septa; the median longitudinal groove cutting through the latter indicates the position of the siphuncle. Rathkeale, county of Limerick. British Museum. (Page 124.)

Fig. 2. Upper part of base of body-chamber of another individual, showing the position of the siphuncle close to the peripheral border. Kildare (probably Clane). Dublin Museum of Science and Art. (Page 124.)

Fig. 3. Initial whorl of another specimen, somewhat larger than the one represented by fig. 1 *a*, in which this part is perfect. Clane. Dublin Museum of Science and Art. (Page 124.)

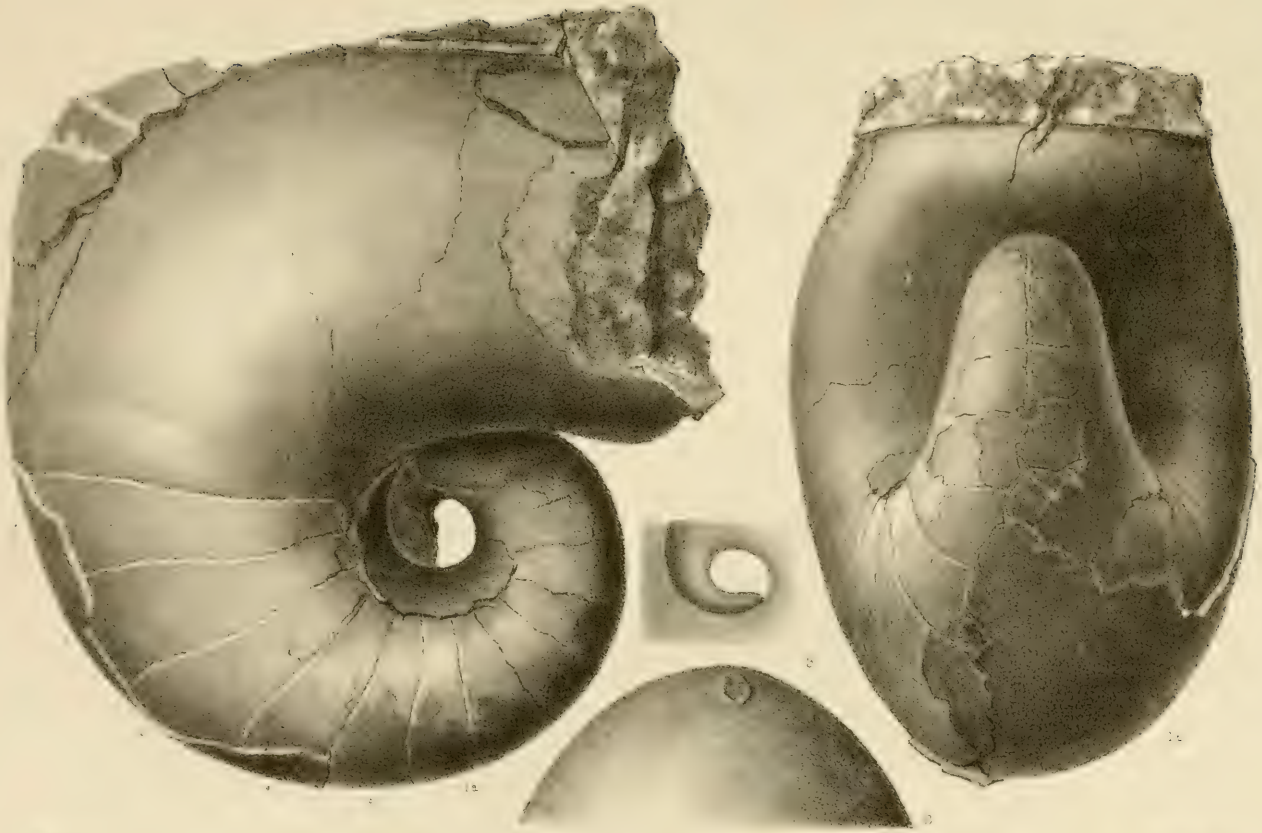


PLATE XXXIII.[1]

SOLENOCHEILUS DORSALIS, *J. Phillips*, sp.

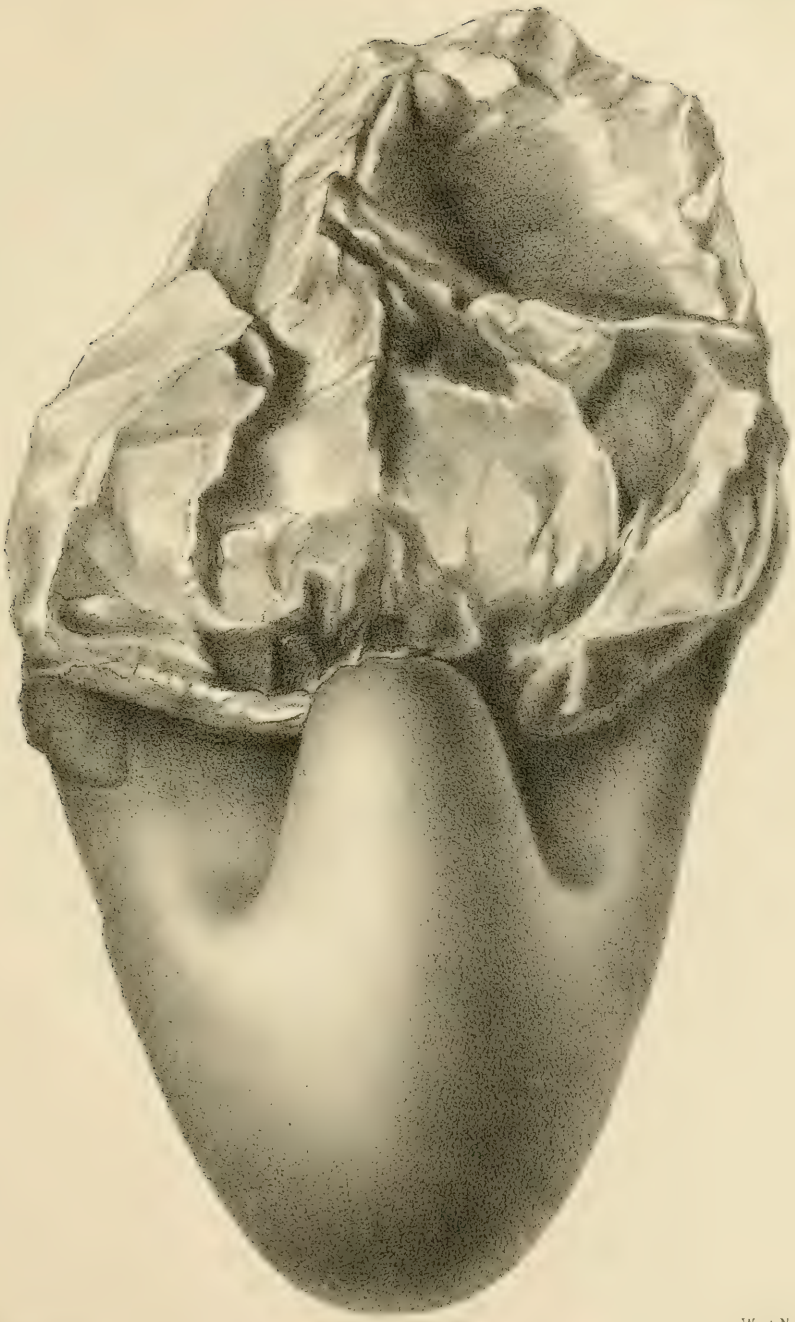
Lateral view of a large and nearly perfect specimen. Clane. Dublin Museum of Science and Art. (Page 126.)

[1] The figures in this and the following plates represent the specimens of the natural size unless the contrary is stated.

PLATE XXXIV.

Solenocheilus dorsalis, *J. Phillips*, sp.

Front view of the individual drawn on Pl. XXXIII. Clane. Dublin Museum of Science and Art. (Page 126.)



A H F del.
W H Crowther lith.

West, Newman imp

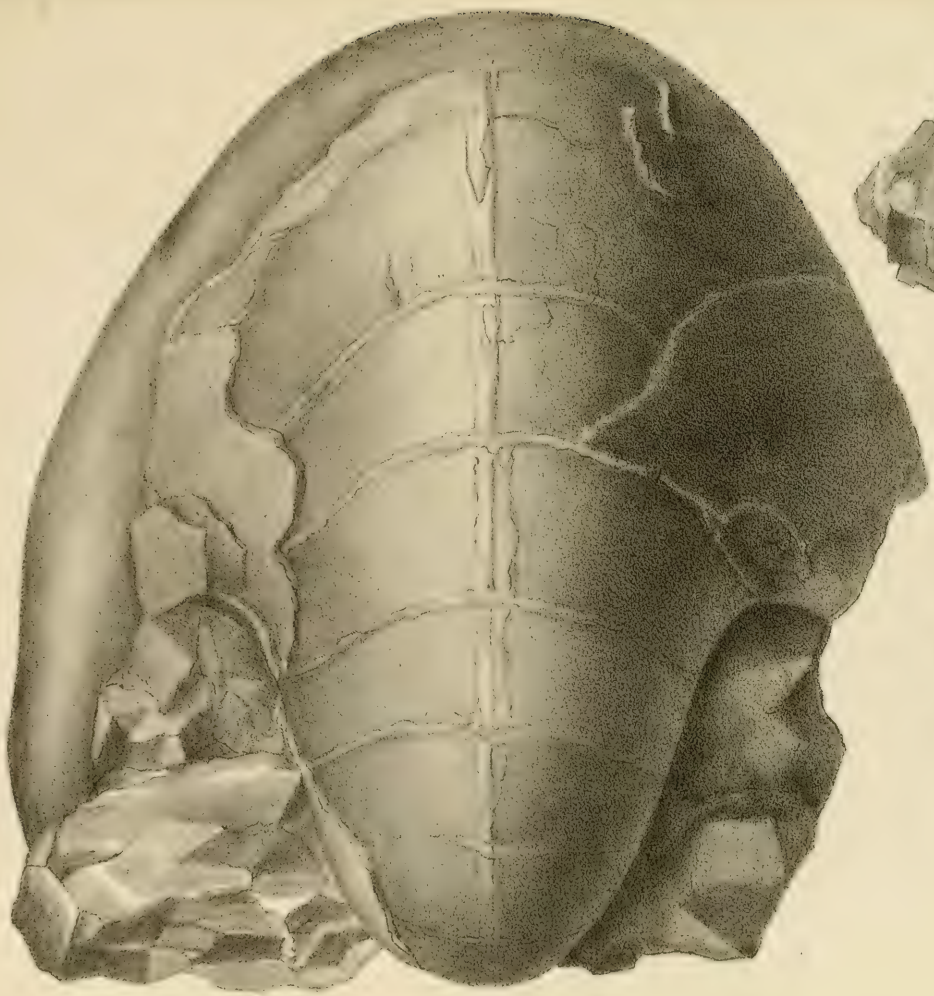
PLATE XXXV.

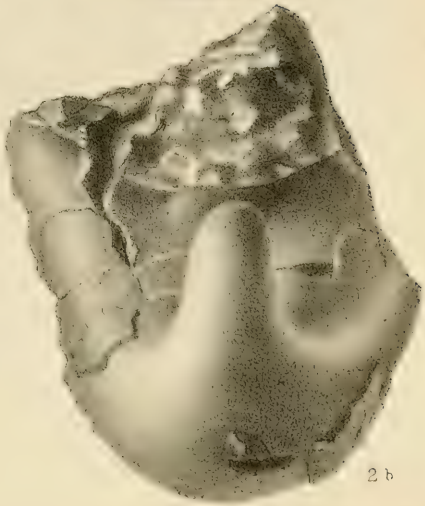
Solenocheilus dorsalis, *J. Phillips*, sp.

Fig. 1. Peripheral view of a large specimen, showing the sutures and the remains of the siphuncle upon the cast. Rathkeale. Dublin Museum of Science and Art (Geological Survey Collection). (Page 127.)

Aipoceras ? Hainesianum, sp. nov.

Fig. 2 *a*. Lateral view of an imperfect and distorted individual. (Since this figure was drawn the matrix has been cleared away from the apical part of the shell, disclosing the fact that the whorls are free—that is, non-contiguous—from the initial point.) 2 *b*. Front view of the same individual. Near Cork. Mr. Joseph Wright's Collection. (Page 131.)





2 b

A & R. del.
W.H. Crewdson lith.

West, Newman imp.

PLATE XXXVI.

SOLENOCHEILUS ? HIBERNICUS, *A. H. Foord.*

Fig. 1 *a*. Lateral view of a nearly perfect individual. 1 *b*. Front view of the same, reduced in size. Ireland (exact locality unknown). British Museum, type specimen (No. C. 4505). (Page 128.)

Fig. 2. Lateral view of a specimen from Bolland, Yorkshire, showing the septation more completely than fig. 1 *a*. British Museum, "Gilbertson Collection" (No. C. 212). (Page 129.)

SOLENOCHEILUS ? CLAUSUS, sp. nov.

Fig. 3. Lateral, somewhat foreshortened view, showing the callus closing the umbilicus. Little Island. British Museum. (Page 130.)

1 b

W H Crowther del.
A H F. dir.

West Newman imp.

PLATE XXXVII.

Brancoceras ornatissimum, *L. G. de Koninck*, sp.

Fig. 1 *a*. Lateral view of the type specimen, showing the closed umbilicus. 1 *b*. Front view of the same, showing the surface of a septum with the cavities between the lobes. 1 *c*. Suture-line. Glenbane East. Dublin Museum of Science and Art (Geological Survey Collection). (Page 132.)

Pericyclus fasciculatus, *F. M'Coy*, sp.

Fig. 2 *a*. Front view of an undistorted specimen. 2 *b*. Lateral view of the same. Clane. British Museum. (Page 135.)

Fig. 3 *a*. Lateral view of a somewhat distorted specimen. 3 *b*. Peripheral view of the same. Midleton. Mr. Joseph Wright's Collection. (Page 137.)

Fig. 4 *a*. Lateral view of a young individual. 4 *b*. Peripheral view of the same. Glenbane East. Dublin Museum of Science and Art (Geological Survey Collection). (Page 135.)

Fig. 5 *a*. Lateral view of the type specimen of "*Goniatites*" *fasciculatus*, M'Coy. 5 *b*. Peripheral view of the same. 5 *c*. Enlargement of a portion of the ornamentation to show more clearly the fasciculate character of the ribbing. Millicent, Clane. Dublin Museum of Science and Art ("Griffith Collection"). (Page 137.)

Fig. 6. Suture-lines of a small specimen where the diameter of the shell is about 30 mm. (A figure of the suture-line of a specimen nearly the same size as the above will be found in the 'Cat. Foss. Ceph., Brit. Mus.,' pt. iii, 1897, p. 150, fig. 71 *c*.) Glenbane. Dublin Museum of Science and Art. (Page 136.)

Pericyclus multicostatus, sp. nov.

Fig. 7 *a*. Lateral view of a somewhat distorted specimen, the umbilical cavity of which is filled with the matrix. 7 *b*. Peripheral view of the same. 7 *c*. Suture-lines of the same. Midleton. Mr. Joseph Wright's Collection. (Page 139.)

Pericyclus Doohylensis, *A. H. Foord and G. C. Crick*.

Fig. 8 *a*. Lateral view of a specimen of the compressed form of the species. 8 *b*. Peripheral view of the same. 8 *c*. Suture-line, taken from fig. 72 *c* of 'Cat. Foss. Ceph., Brit. Mus.,' pt. iii, 1897, p. 151. Doohyle. British Museum. (Page 138.)

W.H. Crowther del.
A.H.F. dir.

West, Newman, imp.

PLATE XXXVIII.

PERICYCLUS SUBPLICATILIS, *G. C. Crick.*

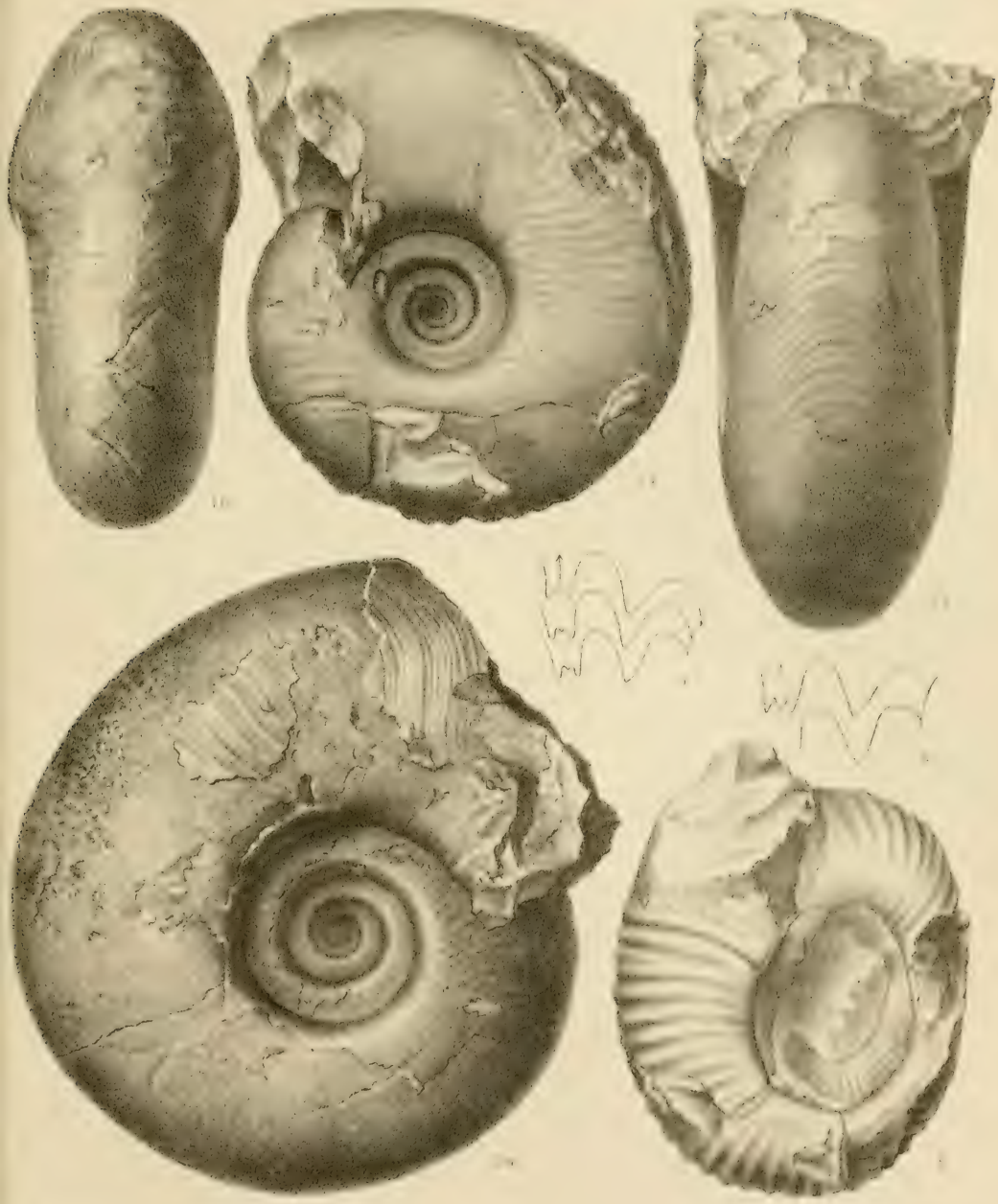
Fig. 1 *a*. Lateral view of an imperfect individual which is not quite so large as others that have been obtained at the same locality. 1 *b*. Peripheral view of the same. 2. Suture-lines from another individual. St. Doulagh's. Woodwardian Museum, Cambridge. (Page 142.)

PERICYCLUS FOORDI, *G. C. Crick.*

Fig. 3 *a*. Lateral view of a remarkably fine specimen with some of the test preserved. 3 *b*. Front view of the same. 4. Suture-lines from a smaller individual. Cloghran. British Museum. (Page 141.)

PERICYCLUS FUNATUS, *J. Sowerby*, sp.

Fig. 5. Lateral view of the distorted and imperfect type specimen. Blackrock. British Museum ("Sowerby Collection"). (Page 134.)



W H Crowther del.
A H F. dir.

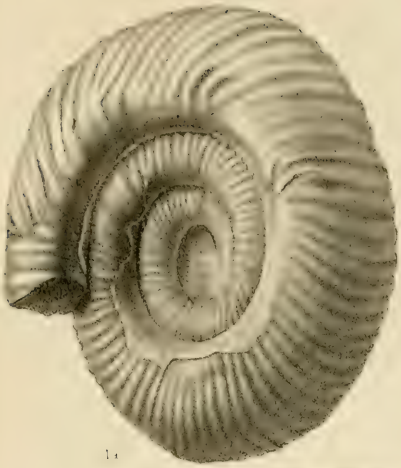
PLATE XXXIX.

PERICYCLUS FUNATUS, *J. Sowerby*, sp.

Fig. 1 *a*. Lateral view of a distorted but otherwise fine specimen, showing the inner whorls which are only imperfectly preserved in the type specimen figured on Pl. XXXVIII. 1 *b*. Peripheral view of the same. Cork. Trinity College, Dublin. (Page 135.)

PERICYCLUS TRAPEZOIDALIS, *G. C. Crick*.

Fig. 2 *a*. Lateral view of the only individual known, showing the strong ribbing with the numerous constrictions. 2 *b*. Peripheral view of the same. 2 *c*. Enlargement of a portion of the ornamentation, showing more clearly the longitudinal lines crossing the ribs. 2 *d*. Suture-lines. Clane. Dublin Museum of Science and Art. (Page 144.)



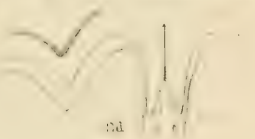
1a

1b

1c

2a

2c



2d

AT Hoffick del et lith
AHF dir

West, Newman imp

PLATE XL.

Pericyclus Bailyi, *G. C. Crick.*

Fig. 1 *a*. Lateral view of the type specimen in which the inner whorls are concealed in the matrix. 1 *b*. Front view of the same, showing the ribbing. St. Doulagh's. British Museum (No. C. 298). (Page 147.)

Fig. 2 *a*. Lateral view of a smaller specimen in which the inner whorls are all exposed to view. From a drawing by the author. 2 *b*. Front view of the same. St. Doulagh's. Woodwardian Museum, Cambridge (No. 439). (Page 147.)

Fig. 3. Suture-line from a specimen formerly in the author's possession; reproduced from Mr. Crick's figure in the 'Ann. Mag. Nat. Hist.,' ser. 7, vol. iii, 1899, p. 439, fig. 7. St. Doulagh's. (Page 147.)

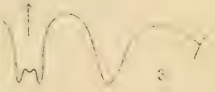
Pericyclus rotuliformis, *G. C. Crick.*

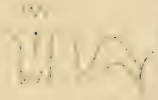
Fig. 4 *a*. Lateral view of the type specimen, with eroded fragments of the test adhering to the cast. 4 *b*. Front view of the same, showing two constrictions. St. Doulagh's. Dublin Museum of Science and Art. (Page 148.)

Fig. 5. Lateral view of a specimen, showing the inner whorls, with nodes. From a drawing by the author. St. Doulagh's. Woodwardian Museum, Cambridge (No. 411). (Page 148.)

Fig. 6. Peripheral view of a somewhat thicker individual than 4 *a*, showing the characteristic constrictions very strongly marked upon the cast. St. Doulagh's. Dublin Museum of Science and Art. (Page 148.)

Fig. 7. Suture-line of an imperfect individual. From a drawing by the author. Glenbane. Dublin Museum of Science and Art (Geological Survey Collection—No. 716 C.). (Page 148.)





West, Newman imp

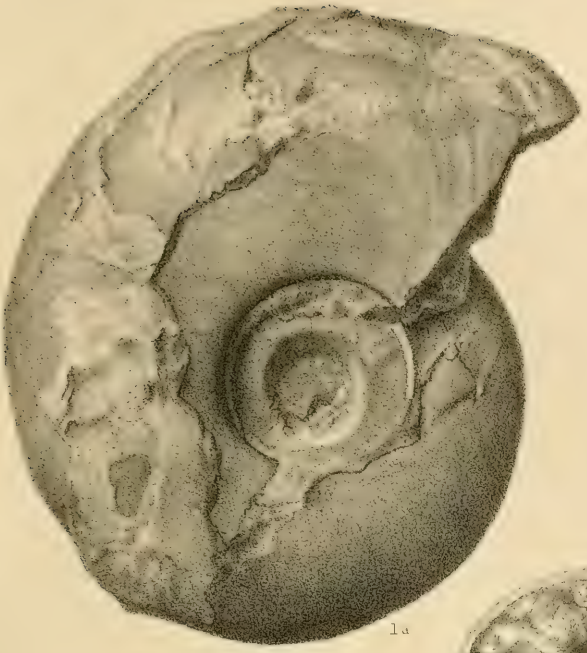
PLATE XLI.

Pericyclus Clanensis, *G. C. Crick.*

Fig. 1 *a*. Lateral view of the type and only specimen, showing fragments of the test. [The lithographer has represented the edge of the inner whorl too angular.] 1 *b*. Front view of the same. 1 *c*. Suture-line of the same. (The lateral lobe is not pointed enough.) Clane. Dublin Museum of Science and Art. (Page 151.)

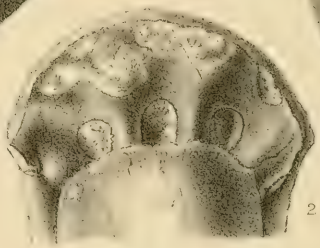
Pericyclus plicatilis, *L. G. de Koninck*, sp.

Fig. 2 *a*. Front view of the distorted type specimen. 2 *b*. Lateral view of the same. 2 *c*. Front view, showing the greater part of a septum exposed by the removal of part of the shell. From a drawing by the author. 2 *d*. Suture-line taken from 2 *c*, now covered again by the replacement of the detached portion. Kilmacat, county of Limerick. Dublin Museum of Science and Art (Geological Survey Collection). (Page 150.)

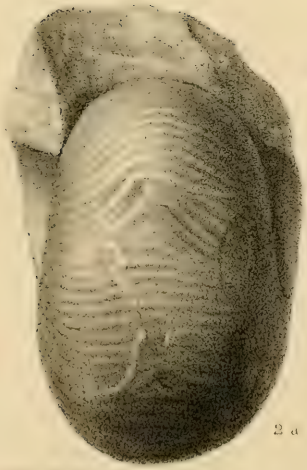


1a

1b

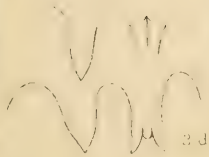


2c



2a

1c



2d

1

ATH Ilse del. et lith.
AHFoord direct.

PLATE XLII.

GLYPHIOCERAS (s.-g. SPHENOCERAS) SPHÆRICUM, *W. Martin*, sp.

Fig. 1 *a*. Lateral view of the cast of a small specimen, showing the suture-lines with great clearness. 1 *b*. Peripheral view of the same. Near Bantry. Mr. Joseph Wright's Collection. (Page 154.)

Fig. 2. Lateral view of an entirely septate specimen, showing constrictions. Ireland (exact locality not known). British Museum (No. 25,294). (Page 154.)

GLYPHIOCERAS (s.-g. SPHENOCERAS) STRIATUM, *J. Sowerby*, sp.

Fig. 3. Periphero-lateral view of a wholly septate fragment, embedded in the rock, showing a shallow constriction. Fig. 4. Crushed specimen, showing the ornamentation and constrictions. Courtlough. Dublin Museum of Science and Art (Geological Survey Collection). (Page 160.)

GLYPHIOCERAS (s.-g. SPHENOCERAS) CRENISTRIA, *J. Phillips*, sp.

Fig. 5. Lateral view of a septate specimen with fragments of test. Ireland (exact locality not known). British Museum (Morris Collection—No. 50,183). (Page 157.)

Fig. 6. Suture-line, taken from fig. 76 of 'Cat. Foss. Ceph. Brit. Mus.,' pt. 3, 1897, p. 161. Bolland (Lancashire). British Museum (No. C. 5080). (Page 157.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) OBTUSUM, *J. Phillips*, sp.

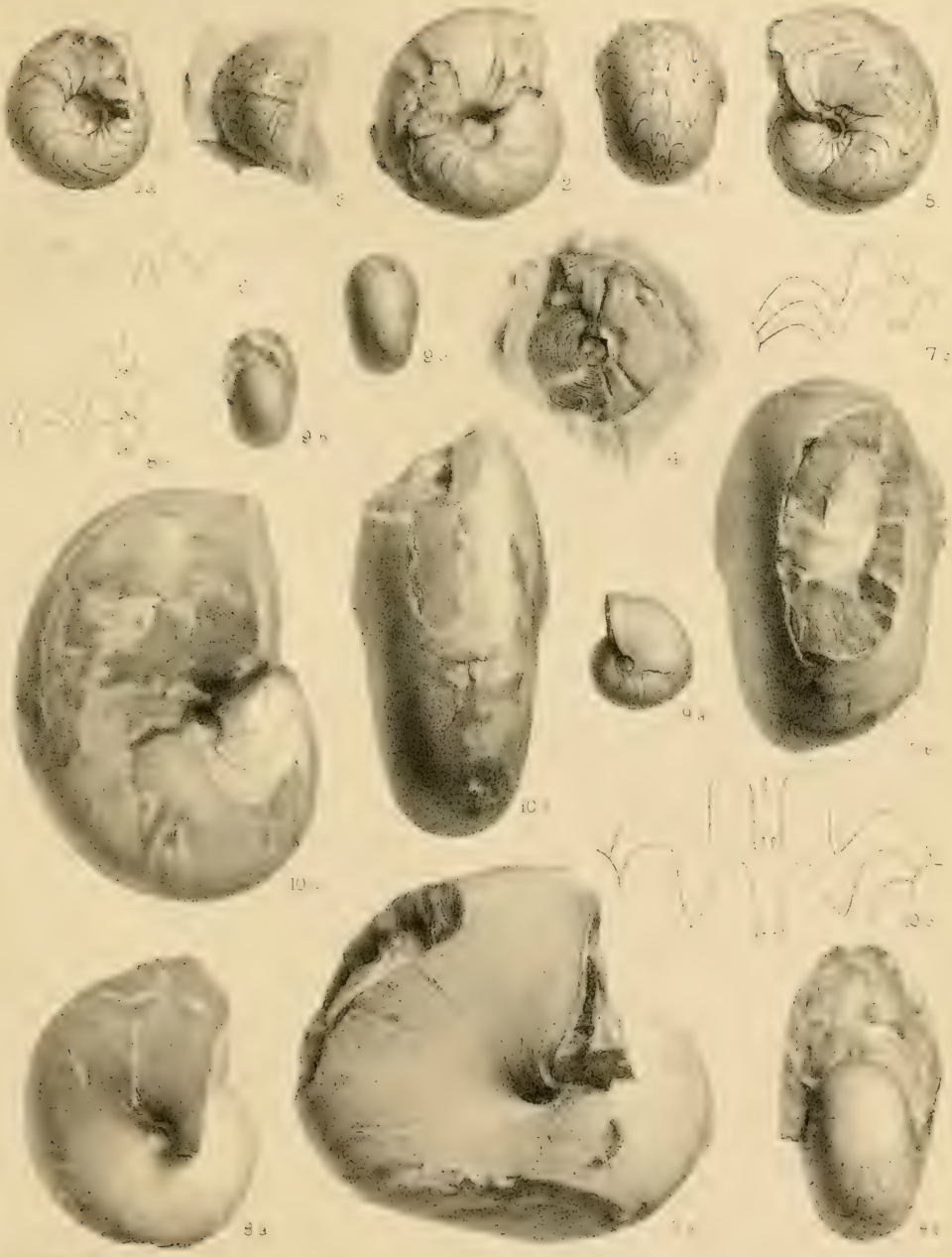
Fig. 7 *a*. Lateral view of a specimen distorted into an ellipse nearly at right angles to the aperture. 7 *b*. Peripheral view of the same. 7 *c*. Suture-lines of the same. Little Island. Dublin Museum of Science and Art. (Page 163.)

Fig. 8 *a*. Lateral view of an undistorted specimen. 8 *b*. Front view of the same, showing sutures artificially exposed. 8 *c*. Suture-lines of the same. Ballynacarriga. Dublin Museum of Science and Art (Geological Survey Collection). (Page 163.)

Fig. 9 *a*. Lateral view of a specimen of what is probably the young of this species. 9 *b*. Front view of the same. 9 *c*. Peripheral view of the same. Ballynacarriga. Dublin Museum of Science and Art (Geological Survey Collection—No. 452). (Page 163.)

GLYPHIOCERAS (s.-g. MUENSTEROCERAS) CRASSUM, sp. nov.

Fig. 10 *a*. Lateral view of the type specimen distorted into an ellipse parallel with the aperture; the sutures artificially exposed. 10 *b*. Peripheral view of the same. 10 *c*. Suture-lines of the same drawn in plan to show both sides. Ballynacarriga. Dublin Museum of Science and Art (Geological Survey Collection—No. 547). (Page 193.)



FH Michael del. et lith.
A H Foord. dir.

PLATE XLIII.

GLYPHIOCERAS (s.-g. MUENSTEROCERAS) ELLIPSOIDALE, *G. C. Crick.*

Fig. 1 *a*. Lateral view of the type specimen. 1 *b*. Front view of the same. 1 *c*. Suture-line from another specimen. Dublin Museum of Science and Art. Fig. 1 *a*. Kildare (exact locality in the county unknown.) Fig. 1 *c*. St. Doulagh's. (Page 194.)

GLYPHIOCERAS (s.-g. SPHENOCERAS) STRIATUM, *J. Sowerby*, sp.

Fig. 2 *a*. Lateral view of a fine specimen with remains of the test, showing the characteristic ornamentation; the sutures and a constriction are also well displayed. [Drawn from a specimen in the British Museum from Derbyshire (No. 33,451); this is intended to supplement the very defective Irish specimens figured on Pl. XLII, the only ones available.] 2 *b*. Suture-line of this species; the lobes and saddles are made much too obtuse in this figure (compare 2 *a*), which is copied from the figure of Sowerby's type specimen ('Cat. Foss. Ceph., British Museum,' pt. 3, 1897, p. 168, fig. 78). (Page 160.)

GLYPHIOCERAS (s.-g. MUENSTEROCERAS) OBESUM, sp. nov.

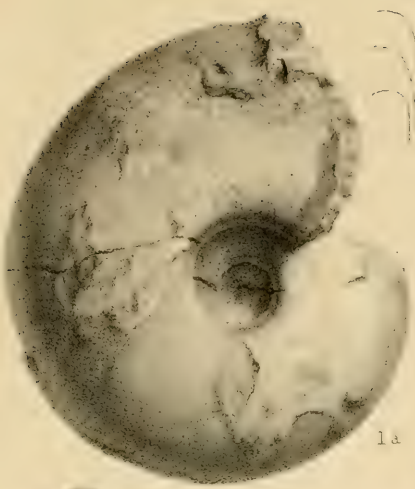
Fig. 3 *a*. Lateral view of the type specimen distorted into an elliptical form in which the longer diameter is nearly at right angles to the aperture. 3 *b*. Front view of the same, showing the sutures. 3 *c*. Suture-lines of the same, showing the invagination of the peripheral lobes. (Page 196.)

GLYPHIOCERAS, sp.

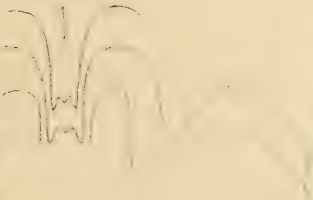
Fig. 4 *a*. Lateral view of the cast of a very small individual. 4 *b*. Front view of the same. Cregg (Nobber). Dublin Museum of Science and Art ("Griffith Collection"). (Page 209.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) TRUNCATUM, *J. Sowerby*, sp.

Fig. 5 *a*. Peripheral view of a small specimen. 5 *b*. Lateral view of the same, showing doubly curved deep constrictions on the cast; fragments of the smooth test are also present. Ballycahane. Dublin Museum of Science and Art (Geological Survey Collection—No. 2963). (Page 165.)



1a



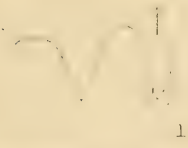
3c

2b

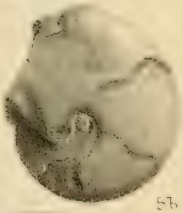
1b

2a

5a



1c



5b

3a

4a

4b

3b.

FH Michael del. et lith
AH Foord dir

West, Newman imp

PLATE XLIV.

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) TRUNCATUM, *J. Phillips*, sp.

Fig. 1 *a*. Lateral view of a large specimen, showing a faint constriction, and, more anteriorly, what appears to be the sigmoidal outline of the aperture. 1 *b*. Peripheral view of the same, showing a slight flattening in this region. Lisnakerry. Dublin Museum of Science and Art (Geological Survey Collection—No. 4124). (Page 165.)

Fig. 2 *a*. Lateral view of the cast of a large specimen, showing two distinct constrictions. 2 *b*. Peripheral view of the same. 2 *c*. Sutures of the same; the last three septa; the peripheral lobe is too narrow. Clane. Dublin Museum of Science and Art. (Page 165.)

Fig. 3 *a*. Lateral view of a cast of typical shape. 3 *b*. Peripheral view of the same, showing truncation. St. Doulagh's. Dublin Museum of Science and Art. (Page 165.)

Fig. 4 *a*. Lateral view of a nearly perfect specimen, showing the smooth test and the nearly closed umbilicus. 4 *b*. Front view of the same with the sutures artificially exposed. 4 *c*. Suture-lines of the same. Clane. Dublin Museum of Science and Art ("Griffith Collection"). [This specimen is somewhat doubtfully referred to the present species; its general features resemble those of *Glyph. obtusum*, but the sutures are more like those of the former.] (Page 165.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) MICRONOTUM, *J. Phillips*, sp.

Fig. 5 *a*. Lateral view of a small (or young?) specimen, showing the fine transverse striæ. 5 *b*. Peripheral view of the same. Kildare (exact locality in the county unknown). British Museum (No. 26,268). (Page 177.)

FH Michael del. et lith.
A H Foard dir.

West, Newman imp.

PLATE XLV.

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) TRUNCATUM, *J. Phillips*, sp.

Fig. 1 *a*. Lateral view of the cast of a young individual. 1 *b*. Front view of the same, showing sutures imperfectly. 1 *c*. Peripheral view of the same. 1 *d*. Suture-lines of the same (imperfect). St. Doulagh's. Dublin Museum of Science and Art (No. 51 *a*). (Page 165.)

Fig. 2 *a*. Lateral view of a very compressed individual, showing very distinct lines of growth near the periphery. (These are made to look too prominent and too broadly curved in the figure.) 2 *b*. Front view of the same. 2 *c*. Peripheral view of the same. Nantenan. Dublin Museum of Science and Art (Geological Survey Collection). (Page 165.)

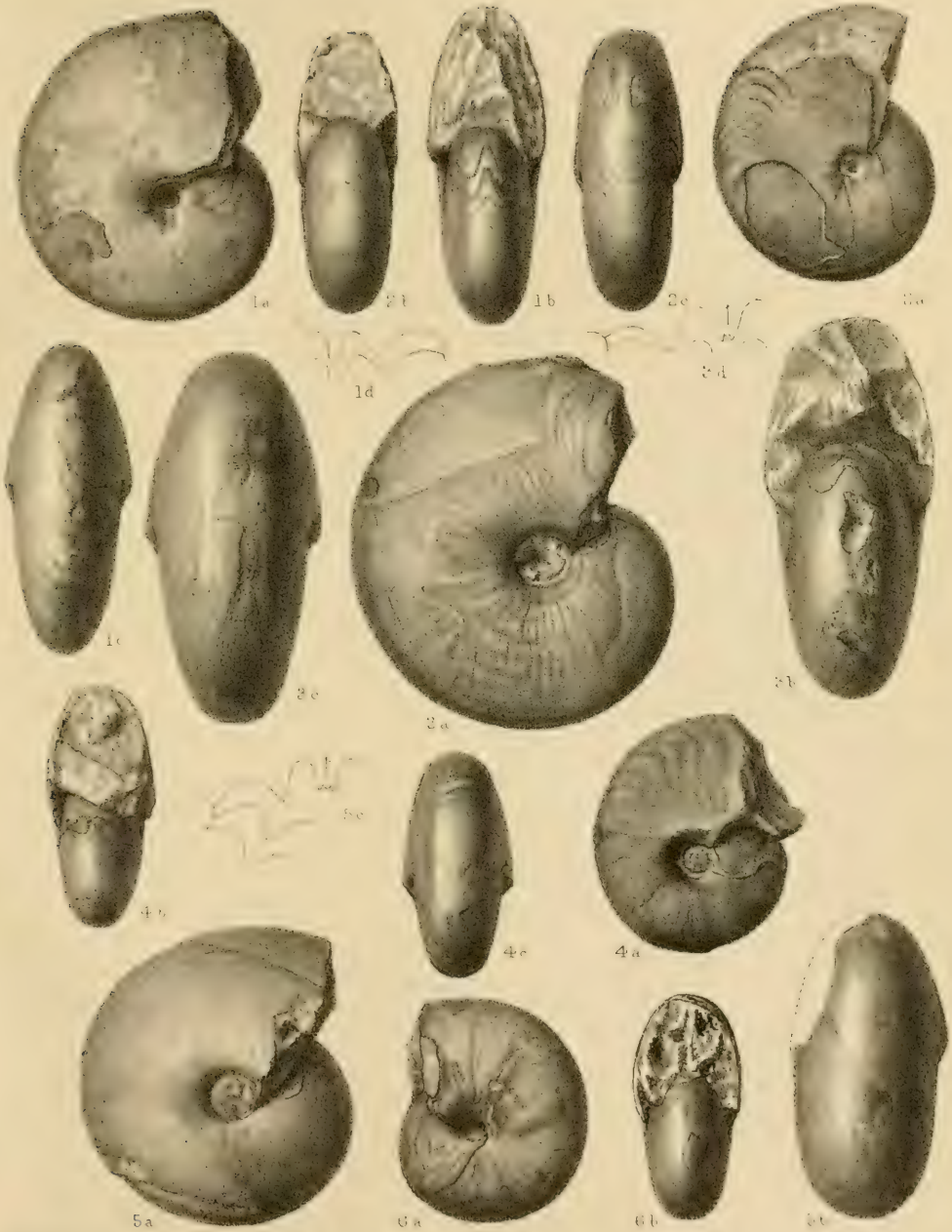
GLYPHIOCERAS (s.-g. BEYRICHOCERAS) SUBTRUNCATUM, sp. nov.

Fig. 3 *a*. Lateral view of the nearly perfect type specimen, showing the wavy lines of growth, and a few obscure spiral lines. 3 *b*. Front view of the same, with suture-lines. *c*. Peripheral view of the same. 3 *d*. Suture-lines of the same. Nantenan. Dublin Museum of Science and Art (Geological Survey Collection—No. 4712). (Page 168.)

Fig. 4 *a*. Lateral view of a young individual, showing the wavy lines of growth. The umbilicus is represented in this figure too angular; it is similar to that of 3 *a*. 4 *b*. Front view of the same. 4 *c*. Peripheral view, showing an imperfect constriction. Fanningtown. Dublin Museum of Science and Art (Geological Survey Collection—No. 1141). (Page 168.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) OCCIDENTALE, sp. nov.

Fig. 5 *a*. Lateral view of the type specimen. 5 *b*. Peripheral view of the same. 5 *c*. Suture-lines of the same. Fig. 6 *a*. Lateral view of a smaller individual, showing some faint lines of growth. (The dark line in the lower part of the figure is only a fracture.) 6 *b*. Front view of the same. Garrihies (Kerry). Dublin Museum of Science and Art (Geological Survey Collection—fig. 5 *a*, No. 4169; fig. 6 *a*, No. 3786). (Page 170.)



ATHollick del et lith
AH Foord dir

West, Newman imp

PLATE XLVI.

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) DIFFICILE, sp. nov.

Fig. 1 *a*. Lateral view of the much eroded and distorted type specimen, which is entirely septate. 1 *b*. Peripheral view, showing that one half of the shell has been shifted sideways across the other. 1 *c*. Suture-lines, well shown also in 1 *a*. Lisnakerry. Dublin Museum of Science and Art (Geological Survey Collection). (Page 171.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) SUBQUADRATUM, sp. nov.

Fig. 2 *a*. Lateral view of a distorted specimen. 2 *b*. Peripheral view of the same, showing truncation. 2 *c*. Suture-lines. Little Island. Mr. Joseph Wright's Collection. (Page 172.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) SPHÆROIDALE? *F. M'Coy*, sp.

Fig. 3 *a*. Lateral view of a somewhat distorted specimen. 3 *b*. Front view of the same. Kilmallock. Dublin Museum of Science and Art ("Griffith Collection"). (Page 173.)

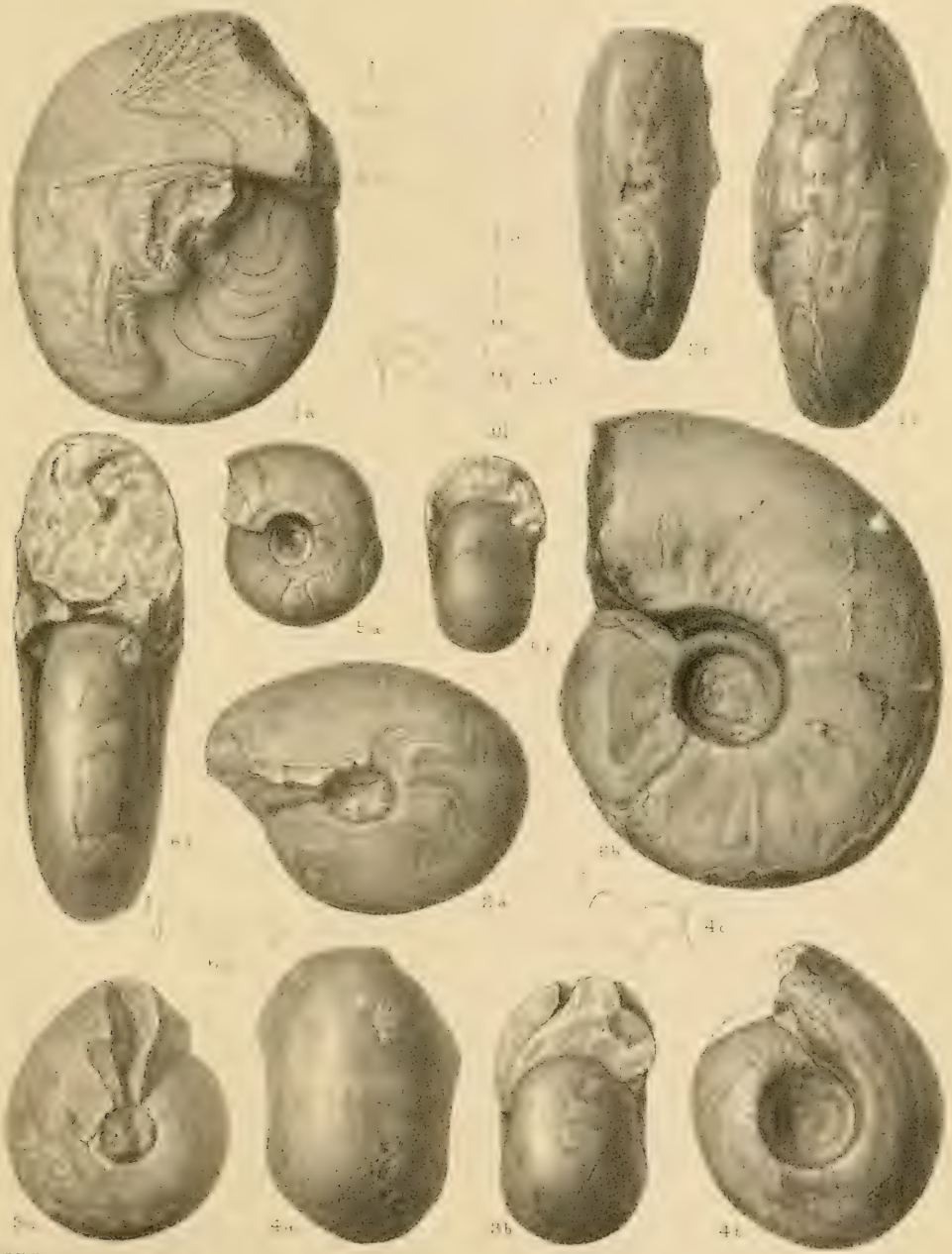
Fig. 5 *a*. Lateral view of a younger undistorted individual, supposed to belong to this species, showing the ornaments of the test. 5 *b*. Front view of the same. The left-hand sigmoid line at the bottom of fig. 5 *a* is only a fracture. Ballynacarriga. Dublin Museum of Science and Art (Geological Survey Collection—No. 255). (Page 173.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) BROWNI? *F. M'Coy*, sp.

Fig. 4 *a*. Peripheral view of a distorted specimen. 4 *b*. Lateral view of the same, showing the very large umbilicus. 4 *c*. Suture-lines, in which the peripheral lobe is not preserved. (The septate part of the specimen is filled with crystalline calcite, the deposition of which appears to have destroyed the inner whorls.) County of Limerick. Dublin Museum of Science and Art ("Griffith Collection"). (Page 175.)

PERICYCLUS LEESONI, *G. C. Crick*, sp.

Fig. 6 *a*. Front view of the type specimen. 6 *b*. Lateral view of the same. 6 *c*. Suture-line of the same, imperfect. Glenbane East. Dublin Museum of Science and Art (Geological Survey Collection). (Page 153.)



A.T.Hollick del. et lith.
A.H. Foord dir

West, Newman imp

PLATE XLVII.

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) CORPULENTUM, *G. C. Crick.*

Fig. 1 *a*. Peripheral view of the imperfect type specimen, showing the lines of growth and the faint longitudinal bands. 1 *b*. Lateral aspect of the same; the inner whorls are not preserved. St. Doulagh's. Dublin Museum of Science and Art. (Page 176.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) CORDATUM, *G. C. Crick.*

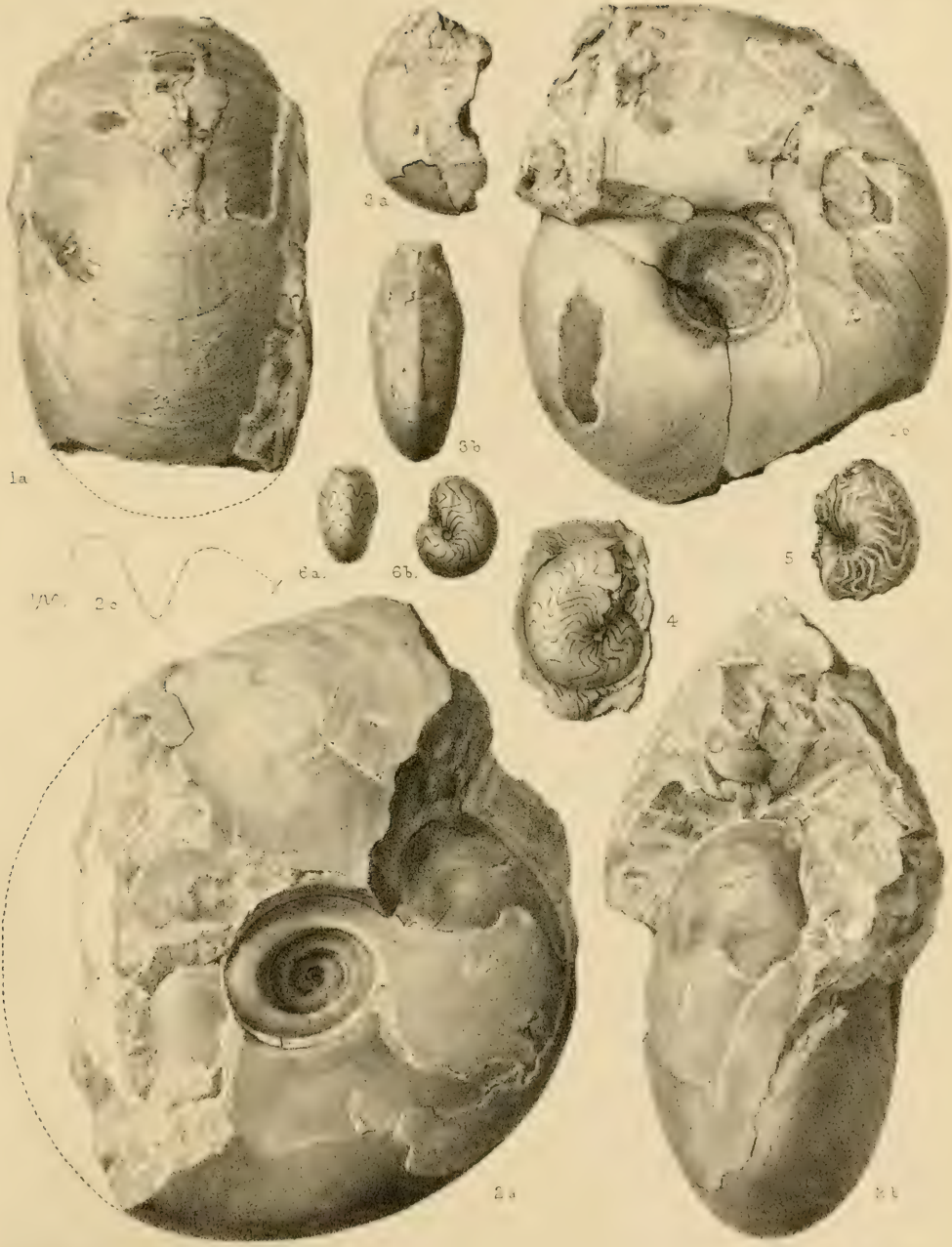
Fig. 2 *a*. Lateral view of the imperfect and somewhat distorted type specimen, showing the very deep umbilicus, in which the inner whorls are exposed; these are well preserved in this specimen. 2 *b*. Front view, showing the sharp edge of the periphery and the cordate form of the whorl in the adult shell. 2 *c*. Suture-line. (The lateral lobe is not made sufficiently pointed in the figure.) Little Island. Dublin Museum of Science and Art. (Page 188.)

BRANCOCERAS ENNISKILLENENSE, sp. nov.

Fig. 3 *a*. Lateral view of an imperfect specimen with most of the test preserved. 3 *b*. Peripheral view of the same, showing the faint keel. Black Lion, near Enniskillen. Dublin Museum of Science and Art ("Griffith Collection"). (Page 208.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) DIADEMA, *H. E. Beyrich*, sp.

Fig. 4. Lateral view of a specimen (cast, in iron pyrites) partly embedded in the matrix. Fig. 5. Lateral view of an imperfect specimen. Fig. 6 *a*. Peripheral view of a smaller specimen. 6 *b*. Lateral view of the same. (The suture-line is well preserved in all these specimens.) Kinsale. Dublin Museum of Science and Art ("Griffith Collection"). (Page 179.)



A. T. Hollick del et lith.
Alf Foord dir.

West, Newman imp.

PLATE XLVIII.

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) CORPULENTUM, *G. C. Crick.*

Fig. 1 *a*. Lateral view of a younger specimen of this species than that figured on Pl. XLVII. 1 *b*. Front view of the same, showing the sutures upon the cast, and a portion of the test. (The lines of growth upon the test are more numerous than they are represented to be in this figure, and the lithographer has omitted to insert the faint longitudinal bands; the umbilicus is made a little too large in both figures, and in fig. 1 *b* the line representing the boundary of the umbilicus on the left-hand side of the figure has been made too low down.) 1 *c*. Suture-lines. (The lateral lobe is too obtuse and the peripheral lobe too narrow.) St. Doulagh's. Dublin Museum of Science and Art. (Page 176.)

GLYPHIOCERAS ? sp.

Fig. 2 *a*. Peripheral view of an imperfect specimen. 2 *b*. Lateral view of the same, showing the wide umbilical cavity, and a strong constriction anteriorly. Black Lion, near Enniskillen. Dublin Museum of Science and Art ("Griffith Collection"). (Page 209.)

Fig. 3 *a*. Front view of an imperfect specimen. 3 *b*. Lateral view of the same, showing the inner whorls and large umbilicus. Black Lion, near Enniskillen. Dublin Museum of Science and Art ("Griffith Collection"). (Page 210.)

PROLECANITES COMPRESSUS, *J. Sowerby*, sp.

Fig. 4 *a*. Lateral view of a large specimen elongated by distortion (reduced in this figure to about one-half of the natural size), showing some of the sutures. 4 *b*. Front view of the same. 4 *c*. Suture-line of the same (natural size; the peripheral lobe not preserved; see fig. 7). Little Island. British Museum. (Page 202.)

Fig. 5 *a*. Peripheral view of a specimen distorted similarly to 4 *a*. 5 *b*. Lateral view of the same, showing the eroded test, with faint lines of growth anteriorly. Midleton. Mr. Joseph Wright's Collection. (Page 202.)

Fig. 6. Lateral view of the specimen supposed to be the one figured by M'Coy under the name of "Goniatites discus" ('Synopsis,' pl. ii, fig. 6), showing the sutures (see left-hand side of figure; the other part has been ground too deep to show them properly). Cork (city). Dublin Museum of Science and Art ("Griffith Collection"). (Page 202.)

Fig. 7. Suture-line of a specimen from Scarlet, Isle of Man, intended to be supplementary to fig. 4 *c*, as respects the peripheral lobe which is here preserved.

Fig. 8 *a*. Lateral view of an entirely septate specimen. 8 *b*. Peripheral view of the same. "Four miles east of Loughrea," county of Galway. Dublin Museum of Science and Art (Geological Survey Collection). (Page 202.)

A.T.Hollick del. et lith.
A.H.Foord, dir.

West, Newman imp.

PLATE XLIX.

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) BILINGUE, *J. W. Salter*, sp.

Fig. 1. Lateral view of an imperfect specimen, showing the characteristic spiral grooves and the linguiform lateral crest. Caher Lane. Dublin Museum of Science and Art (Geological Survey Collection—No. 2208 C.). (Page 186.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) RETICULATUM, *J. Phillips*, sp.

Fig. 2 *a*. Lateral view of a fragment, with some of the test adherent and a very deep and wide constriction upon the cast. 2 *b*. Enlarged view of the ornamentation, showing the fine crenulation of the lines. Rathcahill (No. —3 C.). Dublin Museum of Science and Art (Geological Survey Collection). (Page 182.)

Fig. 3 *a*. Lateral view of a younger individual, showing a fragment of the test and two deep and wide constrictions upon the cast. 3 *b*. Enlarged view of the reticulate lines on the periphery. Foynes Island (No. 833 C.). Dublin Museum of Science and Art (Geological Survey Collection). (Page 182.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) DAVISI ?, *A. H. Foord and G. C. Crick*.

Fig. 4. Lateral view of an imperfect individual doubtfully referred to this species. Rathcahill (No. 3435 C.). Dublin Museum of Science and Art (Geological Survey Collection). (Page 187.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) PULCHELLUM, sp. nov.

Fig. 5. Lateral view, showing the fine ornamentation and two narrow constrictions. Rathcahill. Dublin Museum of Science and Art (Geological Survey Collection—No. 3450 C.). (Page 190.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) SUBRETICULATUM, sp. nov.

Fig. 6 *a*. Lateral view of a cast, showing towards the aperture some faint traces of ornamentation in the shape of sigmoid lines; the suture-lines are well preserved. 6 *b*. Peripheral view of the same, showing the faint median keel. Foynes Island (No. 817 C.). Dublin Museum of Science and Art (Geological Survey Collection). (Page 184.)

Fig. 7 *a*. Lateral view of a smaller specimen, with the test preserved. 7 *b*. Peripheral view of the same. 7 *c*. The ornamentation of the test enlarged, showing the bifurcation of the lines. 7 *d*. Suture-line of the same enlarged. Foynes Island (No. 845 C.). Dublin Museum of Science and Art (Geological Survey Collection). (Page 184.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) DIADEMA ? *H. E. Beyrich*, sp.

Fig. 8 *a*. Lateral view of a young individual apparently belonging to this species, showing the strongly sigmoidal character of the ornaments of the test. 8 *b*. Front view, showing the stronger ribbing on the periphery. St. Doulagh's. Bristol Museum. (Page 179.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) SPIRALE, *J. Phillips*, sp.

Fig. 9. Lateral view of a crushed cast, showing the remarkably regular spiral lines. Loughshinny. Dublin Museum of Science and Art (Geological Survey Collection). (Page 191.)

GASTRIOCERAS CIRCUMNODOSUM, sp. nov.

Fig. 10. Lateral view of an artificial cast, showing the tuberculate margin of the umbilicus and traces of ribbing on the periphery. Fig. 11. Lateral view of a younger individual. Firoda. Dublin Museum of Science and Art (Geological Survey Collection). (Page 196.)

GASTRIOCERAS CIRCUMPLICATILE, sp. nov.

Fig. 12 *a*. Lateral view, showing the plications at the edge of the umbilicus giving rise to fine transverse ribbing, and the spiral lines crossing these. 12 *b*. Peripheral view of the same, showing the median sinus indicated by the form of the ribbing. Fig. 13. Peripheral view of another individual, showing the spiral lines more distinctly than in 12 *b*. "Cliffs of Moher." Dublin Museum of Science and Art (Geological Survey Collection). (Page 200.)

GLYPHIOCERAS (s.-g. BEYRICHOCERAS) TRUNCATUM, *J. Phillips*, sp.

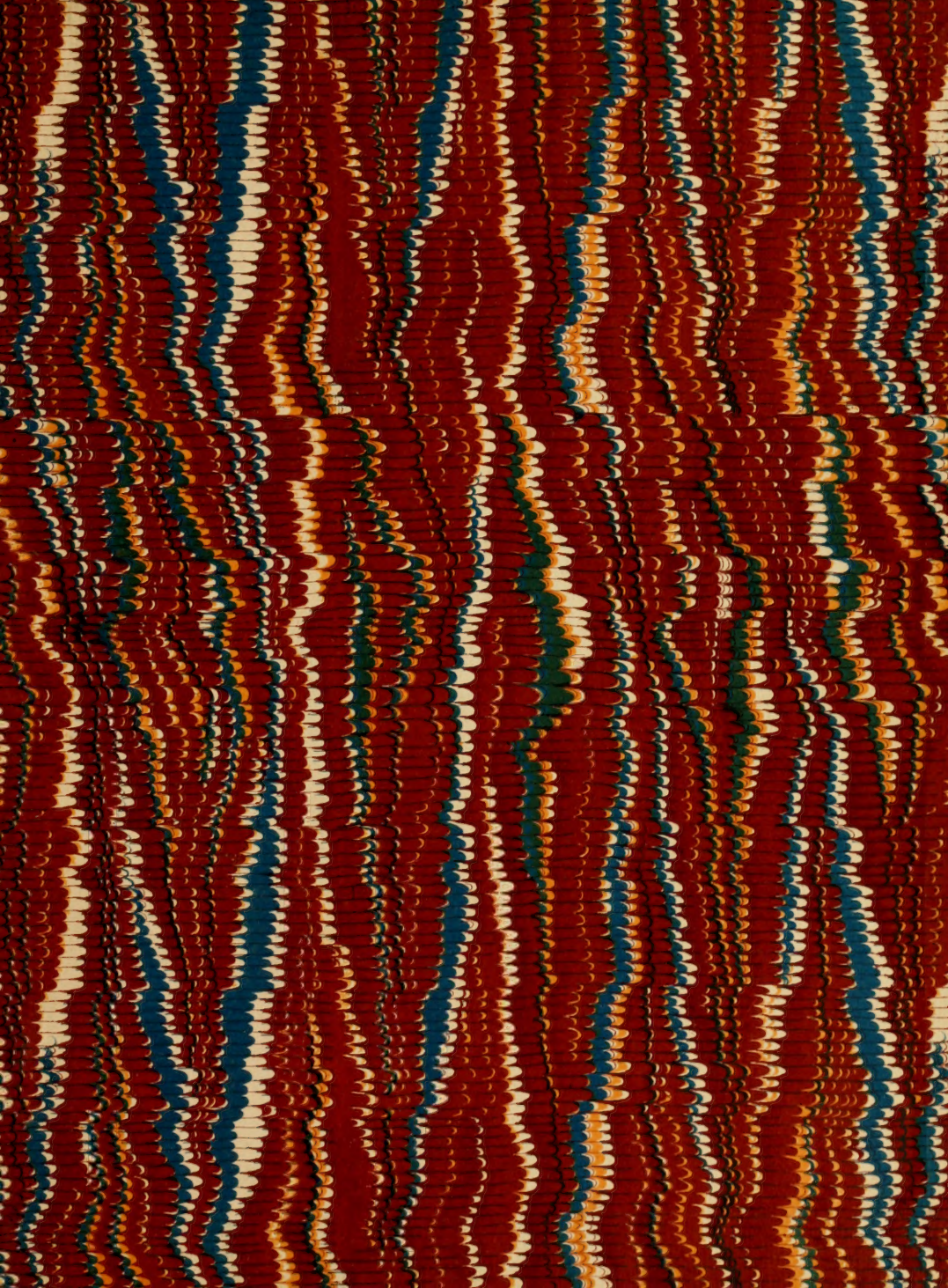
Fig. 14. Suture-line of a large and mature specimen, giving more accurately the form of the sutures than the figure on Pl. XLIV (2 *c*). Kilmacat (county of Limerick). Museum of the Royal College of Science for Ireland. (Page 165.)

TEMNOCHEILUS CORONATUS, *M'Coy*.

Fig. 15 *a*. Lateral view of a fine specimen, showing the heavy nodes at the margin of the periphery and some of the suture-lines. 15 *b*. Front view of the same. Little Island. Mr. James Duffy's Collection (Dublin). (Page 206.)

F.H.Michael del. et lith
A.H.Foord. dir.

West, Newman imp



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